ASSESSING THE IMPLEMENTATION STRENGTH OF FAMILY PLANNING PROGRAMS IN MALAWI: METHODS FOR COLLECTING DATA, CREATING COMPOSITE SCORES, AND LINKING TO KEY OUTCOMES

by
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Abstract

Population growth is a concern for countries around the world, especially in sub-Saharan Africa where growth rates are disproportionally high. In response, many governments have been implementing large-scale family planning (FP) programs. Yet, there are limited ways to assess how strongly these programs are being implemented on the ground. This dissertation develops and tests a tool that assesses the implementation strength of FP programs in Malawi.

Paper One tests the validity and feasibility of collecting data for an implementation strength assessment (ISA) tool via phone interviews. Paper Two explores different methods that combine data across the IS domains and health system levels to construct a summary score for IS at the facility catchment area level. Paper Three tests the association between this summary IS score and utilization of modern contraceptives among women in Malawi. This paper links ISA data with outcome data from the 2015/16 Malawi DHS using a new GIS method.

Paper One found that it was highly feasible to collect ISA data from health workers in Malawi via mobile phone interviews. This paper also found that the most ISA indicators were above the threshold for sensitivity, but were more issues with specificity. Paper Two found that there was little difference between the methods to combine data across IS domains but significant differences between the methods to combine IS data across health system levels. Paper Three found that a higher dose of FP program implementation across the health system was associated with women in Malawi using modern contraceptives.

This dissertation developed a suite of tools and methods that practitioners and researchers can

use to rapidly evaluate the dose of implementation delivered to the population. First, it found that phone interviews are valid, feasible alternative to the traditional, costly in-person method. Second, it described different options to construct summary measures of IS that can be used to understand the combined impact of FP interventions across the health system. Third, this dissertation supported the criterion validity of the summary measure when it found that higher doses of IS were associated with increased modern contraceptive use.

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List of Terms and Abbreviations

AIC	Akaike Information Criteria
AIDS	Acquired immune deficiency syndrome
ASFR	Age-specific fertility rate
BLM	Banja La Mtsogolo
CA	Catchment area
CBDA	Community-based distribution agent
CHAM	Christian Health Association of Malawi
CHW	Community health worker
CI	Confidence interval
CIP	Costed implementation plan
CYP	Couple-years protection
DHO	District health office
DHS	Demographic health survey
EFA	Exploratory factor analysis
FP	Family planning
GDP	Gross domestic product
GNI	Gross national income
HF	Health facility
HFW	Health facility worker
HIV	human immunodeficiency virus
HSA	Health surveillance agent
HW	Health worker
ICs	In-Charges
ICC	Intra-class coefficient
iCCM	Integrated community case management
ICPD	International Conference on Population and Development
ICRW	International center for research on women
IIP	Institute of International Programs
IS	Implementation strength
ISA	Implementation Strength Assessment
KAP	Knowledge, attitudes, and practice
LMICs	Lower and middle-income countries
MCH	Maternal and child health
mCPR	Modern contraceptive prevalence rate
MDGs	Millennium development goals
MEM	Mixed effects model
MOH	Ministry of Health
NEP	National evaluation program
NGO	Non-governmental organization
NSO	National statistics office
OCP	Oral contraceptive pill
OR	Odds ratio
PCA	Principal components analysis
PSI	Population Services International

QoC	Quality of care
RADAR	Real Accountability: Data Analysis for Results
SA	Simple additive
SBCC	Social and behavioral change communication
SDP	Service delivery point
SDGs	Sustainable development goals
SPA	Service provision assessment
SRH	Sexual and reproductive health
SSA	Sub-Saharan Africa
STI	Sexually transmitted infection
TFR	Total fertility rate
UNFPA	United Nations Population Fund
WA	Weighted additive
WHO	World Health Organization
VC	Village clinic
YFHS	Youth-friendly health services

Chapter 1: Introduction and Background

Introduction

The overall goal of this research was to develop a pragmatic tool that health officials and program managers can use to effectively assess the implementation strength (IS) of their family planning (FP) programs: the Implementation Strength Assessment (ISA) for FP programs. There are several steps that needed to be taken to develop such a tool.

First, we needed to define IS in the context of FP programs and what domains comprise this construct. Then, we needed to conceptually map out how IS has an impact on the target population. Once the conceptual framework for IS was developed, then the indicators that fit the different parts of the framework needed to be carefully chosen and tested for validity. Once the ISA tool was ready, data were collected and analyzed in a real-world context. The major questions to be answered included what data collection method was best suited for the tool and the context, how to best represent IS for FP in this context, and how was it linked to the FP outcomes it is hypothesized to affect?

This FP-specific ISA tool was developed and tested in Malawi for several reasons. First, there are real questions about whether Malawi's family planning programs are making a difference. Malawi's population has grown rapidly due to its high fertility rate, especially among the youth. There have been numerous family planning programs implemented across Malawi to try to address this challenge. These programs have been funded and operated by the government and non-government agencies and span the range of FP interventions. In spite of these strategies, contraceptive use and fertility outcomes have improved less rapidly for youth (15-24 year-olds)

than for other adults.

The ISA that was applied in Malawi was the first use of this tool for FP programs. This type of ISA has been applied for integrated community case management (iCCM) in other contexts. This research was part of work conducted by the Institute of International Programs (IIP) and the National Statistics Office (NSO) of Malawi through two projects: the National Evaluation Platform (NEP) and Real Accountability, Data analysis for Results (RADAR).

The Malawi context provided a unique application of the ISA; it was the widest possible way the tool could be applied. The ISA was designed to evaluate either one single FP program or multiple FP programs. Evaluators can choose the ISA domains and indicators that are most relevant to their program(s). The ISA uniquely zooms in to measure the quantity (or 'dose') of a program that is being delivered to the client by the health worker. This dose is measured across five domains that encompass the range of FP service delivery programs.

The 2017 ISA in Malawi evaluated the IS of all FP programs that were delivered to youth clients nationwide. Program 'dose' was collected via phone interviews with all health providers in Malawi that provide FP services. The validity of using phone interviews and the suitability of the ISA indicators for this context was tested through a smaller validation study that preceded the larger application of the ISA across the country. Once the data were collected, this research explored and compared options to summarize the data across the IS indicators, as well as across the health system levels of facility and community health worker. Using the summary measure that resulted from this analysis, the relationship between the dose of implementation with key FP

outputs and outcomes across Malawi was tested. In the context of a full program evaluation and in the absence of a counterfactual, the ISA can lend weight to the hypothesis that the program(s) itself has contributed to a change in outcomes.

The ultimate aim of this research is to develop a practical tool that implementers can use to assess how their FP program(s) are doing while they are still implementing rather than after the program has ended. Implementers can use the results to make the necessary adjustments to their programs. Key actors can then prioritize funding, programs, or policy in specific domains or locations where IS may be weaker or more closely linked to better FP outcomes.

Aims:

Aim 1: To assess the feasibility of using phone interviews to measure implementation strength of family planning programs and the validity of IS data collected by phone

Aim 2: To explore and compare methods to combine data across indicators and health system levels to create a summary score that measures the combined strength of FP programs delivered at the catchment area level

Aim 3: To test the association of implementation strength of family planning programs with key family planning outcomes at the catchment area level in Malawi

Background for Family Planning

Over the last thirty years, the case for provision of FP services has become increasingly clear.

Ensuring affordable, reliable access to a full range of contraceptive methods to the entire population when they need it has proven to have positive effects on a wide range of key outcomes. These include intermediate ones such as unintended pregnancies, mother-child transmission of HIV, contraceptive prevalence rate, and unsafe abortion rates as well as impact such as total fertility rate, maternal morbidity and mortality.[1,2,3,4,5] Provision of FP has also been shown to improve non-health outcomes such as reducing poverty by facilitating economic development and improving the social status of women.[1,7] In fact, family planning has been shown to be one of the most cost-effective public health and development interventions available to address these outcomes.[6,7,8]

The momentum for family planning has gone through waves over the years. The United Nations sponsored several key population and development conferences in the 1960s and 1970s, which largely used the demographic rationale to promote FP. The health benefits of FP gained widespread acceptance in the 1980s.[9] A 'golden era' of family planning occurred in the 1970s and 1980s where FP programs (and funding for them) were more prevalent and led to an increase in contraceptive use and reduced fertility in many regions in the world.[10,11] In this time period, worldwide CPR increased from less than 10 percent to nearly 60 percent, while TFR in lower and middle income countries subsequently fell from around six children per women to around three. These gains were substantial, but uneven. For instance, fertility in sub-Saharan Africa declined at a much lower rate than in Asia and Latin America over the last 50 years.[5] During the 1994 International Conference on Population and Development (ICPD) in Cairo, the paradigm shifted to one of reproductive health and the United Nations Population Fund (UNFPA) developed a global consensus document indicating that FP is a human right, central to gender

equality and women's empowerment. The ICPD broadened the definition of reproductive health to include multiple topics in addition to FP, such as STI/HIV/AIDS, safe motherhood, and gender-based violence.[12,13]

However, investment in FP programs started to decline in the mid-1990s. Global funding for FP fell by more than half, from US$980 million to $340 million from 1995 to 2007.[8,14] Reduction in funding was linked to perceived success in FP programs and the growing need for HIV/AIDS funding. This likely played a significant role in the larger and larger disparity of FP outcomes between countries of high, medium, and low incomes.[15]

In the 2000s, the Millennium Development Goals (MDGs) have been driving global discourse on FP; MDG 4 on child health, MDG 5 on to maternal mortality, and MDG 6 on HIV. The Maputo Program of Action that called for universal access to comprehensive SRH services in Africa was a key outcome of the 2006 African Union Conference of Ministers of Health and repositioned FP as an essential part of attaining the MDGs.[9,16] In 2007, achieving universal access to SRH services was finally added to MDG 5. In turn, major global funders, including the Bill & Melinda Gates Foundation and meetings like the 2012 London Summit on Family Planning, have provided substantial funding and high-level advocacy for funding FP programs and starting initiatives during this time, such as Family Planning 2020 (FP2020).[17,18] Initial results from FP2020 show progress in key FP outcomes, like mCPR, especially across the African continent.[17] The US has been the largest donor to FP/RH in the world, though this is under threat due to the current administration.[19] Still, an estimated 225 million women across the world still have an unmet need for family planning, and regions such as sub-Saharan Africa still have

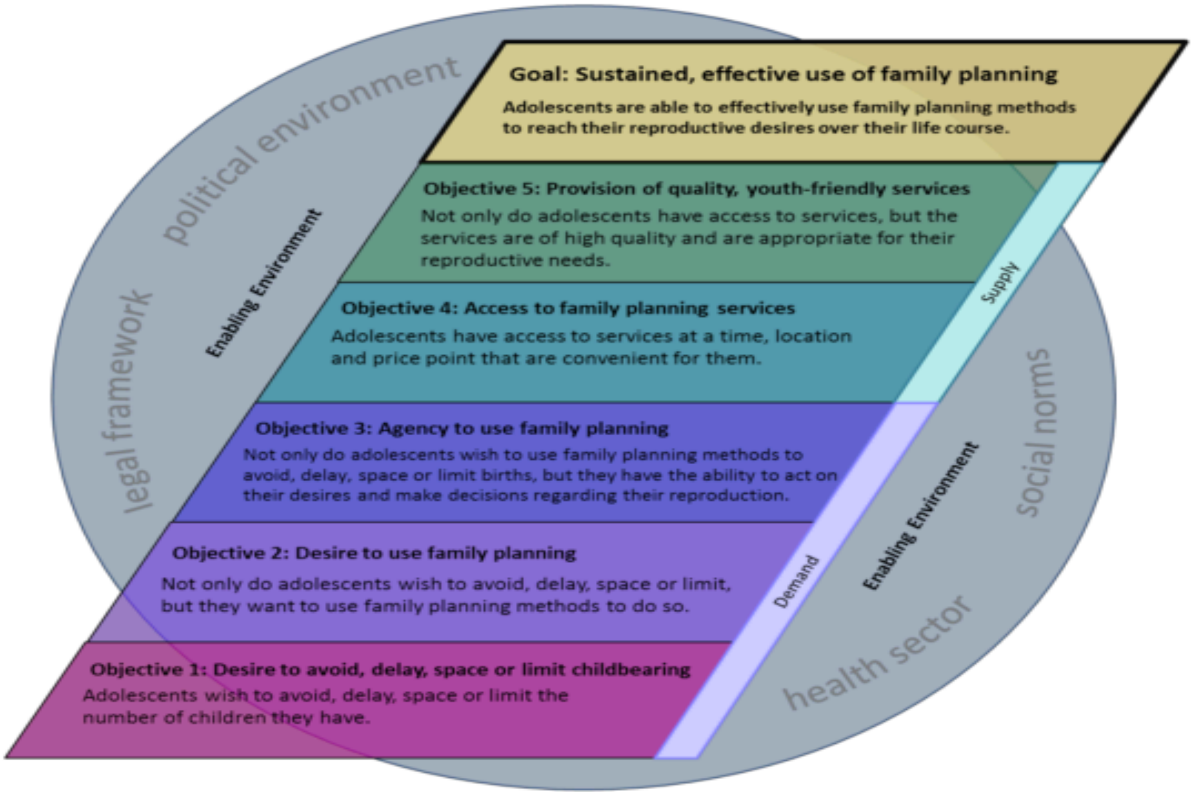
relatively lower contraceptive prevalence rates and high fertility rates.[20,21]

There has been increasing recognition, especially among the less developed countries, on prioritizing funding, goals, and programs towards FP directed at youth.[22] This can also be seen at the global level, through reports from major development agencies like the World Bank and the UN and milestone publications all focusing on the health and FP needs of the youth.[23,24,25] There have also been global targets set for youth, including from the World Health Organization (WHO) at the World Health Assembly, the ICPD, and initiatives and resolutions from the UN.[26,27,28,29] The recently developed Sustainable Development Goals (SDGs) support universal access to SRH services and rights, including FP, via SDG 3.7 and 5.6.[30]

So why is FP for youth important? From a rights-based perspective, every youth should have the freedom to transition into adulthood with the full knowledge and agency to make decisions about their sexual and reproductive health.[13,31] However, there are risks that the youth uniquely face. Biologically, the bodies of adolescents may not have fully matured which place them at higher risk for STI and HIV transmission as well as for more problematic pregnancies and childbirths that are less common in adult women.[32] Moreover, use of contraceptives reduces the need for abortions and increases intervals between births, which reduces birth risks.[25] Youth also face societal challenges, including stigma related to sexual practices and contraceptive use, pressure for girls to get married at a young age, and gender differences in norms for sexual behavior.[56] Structurally, youth also face barriers to accessing FP knowledge, counseling, and methods in a private and confidential way.[57] This can lead to lack of awareness, such as confusion over potential side effects. When young girls are able to choose when they want to have a child and

transition into adulthood in a healthy, educated, and empowered way, it has ripple effects on their families, communities, and countries.[32] Similarly, investing in youth FP not only has a strong effect on health outcomes, but can also transform societies.[33,34] The International Center for Research on Women (ICRW) developed a valuable conceptual framework from a systematic review of youth FP literature that depicts the major barriers that youth face and the objectives that aim to minimize them.

Figure 1.1: Conceptual framework from ICRW for improving youth family planning



*From McCleary-Sills, A., Sexton, M., Petroni, S., Kanesathasan, A., Edmeades, J., Warner, A., Hollingworth, G. (2014). Understanding the Adolescent Family Planning Evidence Base July, 2014. *ICRW*

The first three objectives of the framework above focus on the demand (youth client) side: starting from building the knowledge about childbearing among the youth and then progressing

towards building the desire and agency for FP. The latter two objectives focus on the supply side (the health system): increasing access and quality of FP services provided to youth populations. The ultimate goal is to have sustained and effective use of FP methods by the youth throughout their transition to adulthood. The conceptual framework for the ISA theorizes how stronger IS of FP programs can affect these five objectives.

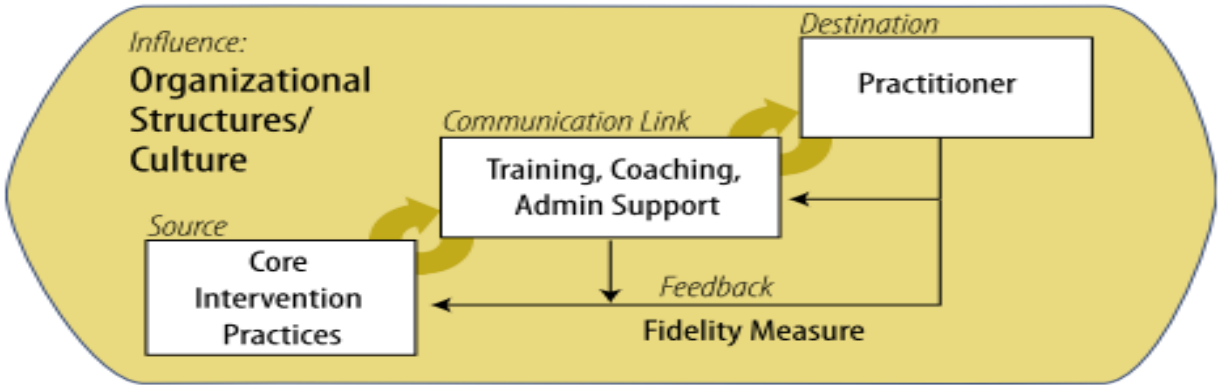
As noted in the previous section, Malawi is particularly interested in addressing how strongly their FP programs directed at youth are being implemented. The next sections will introduce the concept of implementation strength and how it relates to the FP concepts presented above.

Background of Implementation Strength

Implementation Research

While the importance of a set of FP interventions that have proven to be effective cannot be underestimated, it is only the first step in reaching the ultimate goal of improving health. Translating and implementing these interventions through programs or policies in real world contexts, with all its complexities and challenges, is a difficult and important task. The growing field of implementation research aims to tackle this well-documented gap between what is known as efficacy and effectiveness: the performance of an intervention under ideal or controlled conditions versus performance under real-world conditions.[35] The conceptual framework below proposed by Fixsen et al provides a strong visual depiction for implementation research.

Figure 1.2: A Conceptual Framework for Implementation of Defined Practices and Programs



This framework boils down implementation to its five essential components. First is the Source, which refers to the original form of the program that was developed. This connects to the Communication Link, which is the actual actor(s) who implement the program with fidelity, strength, and quality. This links to the destination, which is the actor that houses, supports, and/or funds program installation. These three actors are connected by a feedback mechanism where information about the implementation flows. Finally, all of this operates within a sphere of influence that can include social, political, cultural, and other factors. Ideally, this process should result in intended positive changes on stakeholders.[35] A number of key concepts housed within this framework include understanding the stages of the implementation process and what drives implementation (such as competency, organizational, and leadership drivers), which are described in detail by the Active Implementation Framework.[36]

Implementation research can explore the contextual factors that affect implementation, the implementation process itself, or the outcomes of the implementation.[37] The different areas that implementation research studies can cover are outlined in the table below.[38]

Table 1.1: Major implementation research areas and the questions they aim to answer

Implementation Research Topic	Also Referred to as:	Implementation Question it Aims to Answer
Acceptability	Participant responsiveness	How agreeable are the program activities to stakeholders, including practitioners, target population.
Adaptation	Program modification, reinvention	What, if any, were the changes made to the original program and why/how did they occur?
Feasibility	Practicality, actual fit, utility	Can the program be implemented to fit the real-world context?
Fidelity	Adherence, compliance, integrity	How much did actual implementation of program activities match the originally intended program plan?
Monitoring of arms	Treatment contamination	What was the nature and amount of services received by members of the control and comparison groups?
Program reach	Coverage, program scope, access	What was the rate of involvement and representativeness among the target population?
Program uniqueness	Program Differentiation	How much can a program's theory and practices be distinguished form other programs
Quality	QoC	How well are the different program components implemented?
Strength	Dosage, Intensity	What program quantity has been delivered
Sustainability	Institutionalization, maintenance	Can the program be sustained in a given setting i the long run?

*Adapted from Durlak, J.A. (1998). Why Program Implementation Is Important? *Journal of Prevention & Intervention in the Community,* 17**,** 5-18 and Peters, D. H., Adam, T., Alonge, O., Agyepong, I. A., & Tran, N. (2014): Implementation research: what it is and how to do it. *British Journal of Sports Medicine*, *48*(8), 731–736

These approaches to implementation research don't exist in isolation. They likely will overlap and influence each other. For instance, the level of acceptability of the program will likely affect its reach or sustainability. It is important that this is taken into account when formulating the implementation research question, conceptual framework for the process, and developing the study design.[37] Of the approaches above, this research will focus on implementation strength.

Implementation Strength

Implementation strength can be defined as an approach that "measures the strength or intensity with which packages of interventions are delivered as they are rolled out, with a view to

exploring the association between implementation strength and public health gains."[39,40,41,42,44] In other words, ISA tools intend to reflect the amount of a program that is *delivered*, instead of how much of a program is *received.*

Implementation strength differs from the concept of intervention fidelity. Fidelity measures how closely an intervention is actually implemented compared to the way it was *supposed* to be implemented. In other words, how close did the intervention or program get implemented compared to the original plan.[43] While the two approaches are related, ISAs are more interested in the quantity of a program implemented in practice, regardless of how close it followed the initial plan or protocol.[44]

Why Implementation Strength?

Implementation strength can be a valuable tool for the following four reasons:

- Insufficient implementation is commonly cited as a reason for lack of impact.[64] ISAs can complement traditional impact evaluations, as they can provide evidence that changes in impact were due to strong program implementation.
- ISA tools represent a more pragmatic approach to evaluation that is gathering steam in international development research.[31] Randomized trials are often quite difficult to conduct in real-world applications of FP delivery.[3,5,7,45]
- ISA tools can provide rapid feedback to implementers or researchers at different points in the implementation of a program.
- ISA tools focus largely on health facilities and providers, rather than on client interviews. Depending on design, even rigorous and well-conducted provider surveys are often

cheaper, easier and quicker than client exit and household surveys.

A recent systematic review of implementation strength assessments across different topic areas by Hargreaves et al reviewed 26 studies, demonstrated that there is a myriad of ways ISAs can be designed and applied.[44] The aspects of IS that are measured can vary widely, from intensity or quantity of a health extension program's activities that were delivered, to the amount of spending on a HIV prevention approach, or the duration of implementation.[46] Data collection can vary from acquisition of routinely-collected data, extraction of program documents, to primary quantitative and qualitative data collection. Measures of IS can be developed at the health facility, district, and/or national levels depending on the program.

There are a number of options for creating IS measures. These measures can be treated individually or combined to create scales. Others studies have used absolute or proportional indicators for comparison. This process can get complicated, especially when developing composite indices because of challenges around weighting.[44] Using an index may be hard to understand by the very practitioners it is meant to inform, and thus lose its practical usefulness.

The ISA in Malawi evaluated a nationwide strategy that was implemented through multiple programs and program implementers rather than just a single one. There is evidence within IS literature that supports this type of evaluation, where multiple programs aiming for common outcomes are evaluated for IS. For instance, Teague et al assessed IS in fifty different programs serving people with severe mental illness.[47] Another example is Orwin who assessed the implementation of a variety of interventions targeting different populations with substance abuse

problems.[48] The District Documentation that is part of the parent study aims to understand the details of the different FP programs being implemented in each district.

Once IS indicators are defined and measured, some studies chose to explore the association between IS and relevant public health outcomes.[38] These studies treat IS as a primary exposure in a dose-response relationship. Attention was paid to the contextual factors that could serve as confounders or effect modifiers in the relationship between IS and outcomes.

Chapter 2: Study Setting & Parent Study

Malawi is a landlocked, low-income country in sub-Saharan Africa bordering Tanzania, Mozambique and Zambia. It has an estimated total population of 16.4 million people and 54% of this population is under 18.[49] While about 86% of the population lives in rural areas, it is still one of the most densely populated in Africa with an estimated 184 people per square kilometer. Much of this population (nearly 70%) lives in poverty; Malawi is one of the poorest countries in the world with a Gross National Income (GNI) of $753 per capita.[50] On the United Nations Human Development Index, Malawi ranked 173 out of 188 countries in 2014. On the health financing side, real per capita GDP growth has been minimal, rising from US$241.5 at independence to US$494.4 in 2015. As a result, poverty levels have been consistently high and only reduced by 2% between 2004 and 2010. Rural poverty increased from 55.9% in 2004 to 56.6% in 2010, while extreme poverty levels also increased.[51]

The country is divided into 28 districts, which comprise 3 large regions. Development indicators differ widely among these three regions. For instance, the Central and Southern regions have

more impoverished people than the Northern region. There are two main urban centers, in Lilongwe and Blantyre, and indicators differ widely between these urban centers and rural areas. For instance, 46% of those in urban areas have electricity, while only 3% in rural areas do.[50] Malawi enjoys a democratic government.

Health System of Malawi

At the health system level, the main constraints that limit the country being able to address these and the myriad of other health issues stem from: (i) technical inefficiencies in resource allocation and use, (ii) inadequate supply of health service inputs (including health workers, infrastructure, medicines), (iii) poor governance, (iv) low domestic financing and high dependency on external support, and (v) a large cohort of young people.[52]

Malawi's health financing system can be characterized as a pooled, supply-side, publicly funded system. There is no substantive social health insurance or pre-pooled scheme in Malawi. The central government provides annual budget allocations to the district health offices that subsequently fund government-run health facilities that are offered free to the public.[53]

Malawi is currently experiencing a dual burden of communicable and non-communicable disease. The highest cause of death is HIV, with a prevalence of 10.6% of the population, while the second-highest cause of death is NCD-related. Malawi has one of the highest maternal mortality rates in the world, at 675 per 100,000 live births. The country successfully did, however, meet MDG 4 by reducing child mortality by two-thirds compared to its level in 1990.[54]

Population concerns in Malawi

One of the most pressing concerns for the country is their rising population. Malawi's population has grown rapidly from 4 million to 16.4 million people between 1966 and 2015.[1] The current population growth rate is 2.8 and if this continues, Malawi's population could boom to 26.1 by 2030 and triple their 2008 population size to 45 million people by 2050.[53] The improvements in child survival, along with HIV treatment and other public health successes have contributed to an increase in the number of youth starting to enter adolescence. Youth currently make up the majority of the population (64% of the population is under 25 years old), and in absolute terms will contribute to great population growth in coming years.[3]

According to the most recent Demographic Health Survey (DHS), total fertility rate (TFR) appears to have dropped dramatically from 5.7 in 2010 to 4.4 in 2015, although it varies considerably by district.[55] This represented a giant leap downward for TFR and there are scant examples around the world of TFR dropping by such a large amount. Modern contraceptive prevalence rate (mCPR) has been rising quickly (8 times what it was in 1992) while TFR had been reducing at a slower rate until this measurement in 2015. The proportion of women not using any modern contraceptives has halved in 23 years. Injectable use has been the most commonly used method and has steadily increased. One of the key items to spotlight is the rise of implants use, which grew from near zero to over 11% in 2015. This is significant because implants are a long-acting contraceptive method, while the other popular methods are all short-acting.

Across several different relevant indicators, youth in Malawi exhibit a less favorable trend than

the rest of the population. For instance, the 2015 DHS showed how every age group (of married women of reproductive age) experienced steep increases in mCPR from 1992 to 2015, except the 15-19 one. Other key indicators such as unmet need and demand satisfied for FP were consistently worse among 15-19 year-old women in Malawi throughout the last 23 years as well. While all age-specific fertility rates (ASFRs) have decreased gradually from the early 1990s to now, the youth have weaker outcomes than the rest. These weaker outcomes among youth are particularly challenging because the literature clearly shows the links between early age of first birth with higher TFR, maternal mortality, and poorer socioeconomic status and education impacts.[56,57] For these reasons, the government identified reducing the fertility rate amongst their youth as a key objective in their most recent health policies and strategies.[49,58]

In fact, the government recently released its Costed Implementation Plan for Family Planning, 2016-2020 (CIP). This document was a result of the need for a national plan to meet Malawi's commitment at the 2012 London Summit for Family Planning to achieve a mCPR of 60% by 2020 (FP2020), with a focus on reaching 15-24 year-olds. The CIP outlines the key goals and timelines that the government has in FP for the next five years, the programs and activities that need to be in place to achieve these goals, and the money it will cost to fulfill them via government budget and resource mobilization among partners.[49] Existing government programs like the Youth-Friendly Health Services (YFHS) program (which was started in 2007) are highlighted in the CIP as part of the larger government strategy.[58] There are also has been a myriad of non-governmental partners implementing FP programs across the different districts of Malawi in a wide range of thematic areas, which has likely led to differential access, quality, and impact among youth across the country.

Parent Research

Due to these issues, the government of Malawi requested that the Institute of International Programs (IIP) at the Johns Hopkins Bloomberg School of Public Health, in partnership with the National Statistics Office in Malawi (NSO), conduct an independent evaluation of how well current FP programs were addressing the challenges facing youth in Malawi. In response, IIP and NSO are leading the studies listed in Table 2.1 below:

Table 2.1: Components of IIP-NSO research on family planning among the youth in Malawi

Component	Description	Timeline
Qualitative Study of FP Preferences	Conduct qualitative interviews of FP providers and youth clients	Jun-Aug 2016
Validation and Pre-Test of ISA in 2 districts in Malawi*	Determine the reliability/feasibility of mobile interviews in comparison to in-person interviews	Apr-May 2017
Application of ISA census in all 28 districts of Malawi*	Assess the "dose" of the FP delivered to youth via mobile interviews and the association with key FP outcomes	Jul-Aug 2017
District Documentation of FP Provision across Malawi	Document the existing youth FP programs and existing facilitative/obstructive conditions in each district	Aug 2017
Quality of Care Study of FP provision	Investigate the quality of FP delivered by providers via in-person methods	Jan-Mar 2018

*Subject of this dissertation proposal

This research was conducted as part of the larger IIP programs called the National Evaluation Program (NEP) and Real Accountability: Data Analysis for Results (RADAR). Both projects were funded by the Canadian government: NEP to build capacity to evaluate maternal, child health and nutrition programs in Mali, Malawi, Mozambique and Tanzania, and RADAR to design a set of measurement tools that can be used to improve accountability for Canada's reproductive, maternal, neonatal, child health, and nutrition investments. The RADAR project aims to develop these ISA tools for a variety of topic areas, including FP, maternal and child

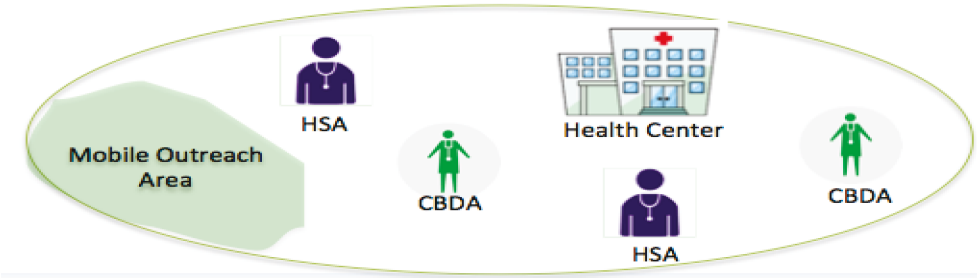
health (MCH), and nutrition. It aims to build QoC (quality of care) tools for the same types of programs. These tools will be tested in NEP countries before being released for use by implementers, countries and evaluators globally. As part of the larger IIP team, we developed the ISA tool to evaluate youth FP programs, and contextualized and validated the tool and methods of data collection for application in Malawi. This served as the first application we are aware of that uses an ISA to evaluate youth FP programs.

Application of ISA in Malawi

One must first understand the service delivery context in Malawi before an ISA is applied. Malawi has been facing a health worker shortage for decades, especially for doctors and nurses.[59] The country has embarked on using community-based distribution to fill the gap, especially given that popular contraceptive methods among the youth in Malawi (e.g. condoms, oral contraceptive pills, injectables) are relatively simple to distribute.[55] There is much literature that examines the use of community health workers to extend services and its mixed effects.[60]

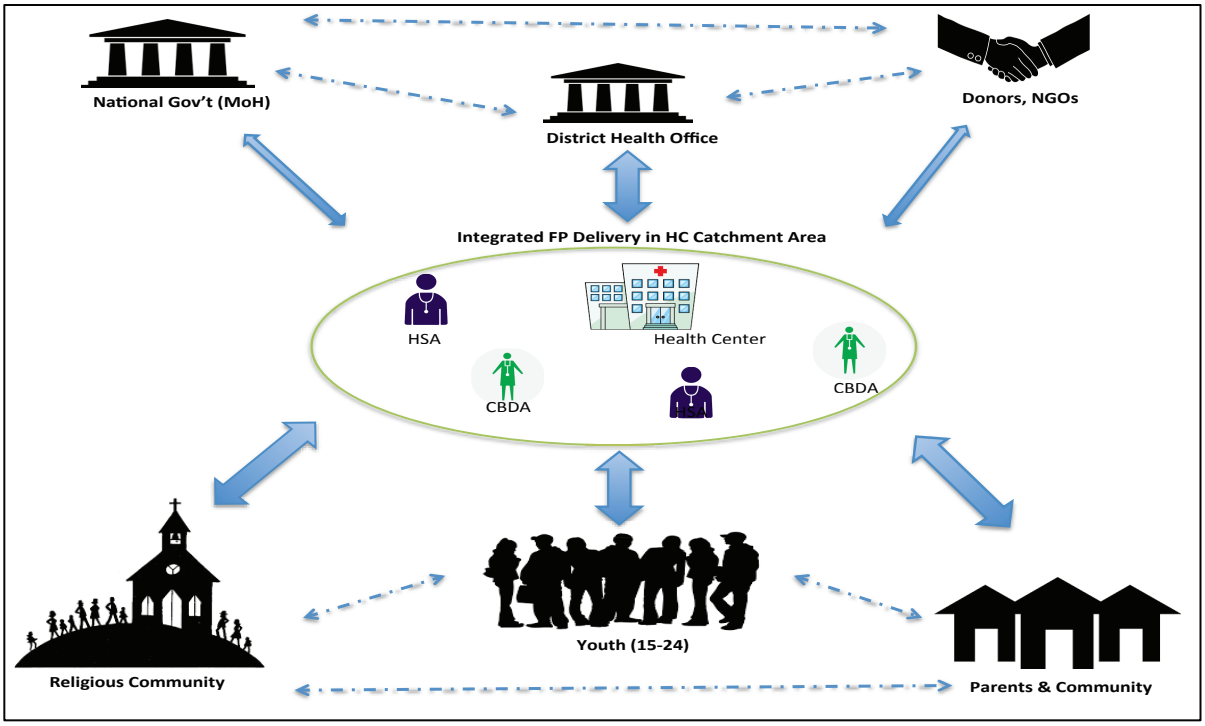
There are three main service delivery points (SDPs) for FP in Malawi: workers in the health facility (HFWs), health surveillance agents (HSAs), and community-based distribution agents (CBDAs). The Malawi government has a policy that there should be one HSA per 1000 population, though in reality, the number of HSAs deployed varies across districts.[53] National guidelines also stipulate that there should be 2-3 CBDAs per HSA in each CA. There could also be hard-to-reach areas in CAs that are supported by mobile outreach clinics. Figure 2.1 below depicts what a sample catchment area in Malawi could look like.

Figure 2.1: Integrated service delivery environment within the catchment area of a facility



HFWs typically provide several forms of contraceptives, including implants, injectables, condoms, and oral contraceptive pills (OCPs). HSAs provide injectables, condoms and OCPs, while CBDAs provide condoms and OCPs; both deliver health education talks but CBDAs do this more door-to-door. The ISA in Malawi collected data from these three health worker cadres in order to determine the implementation strength of FP programs in Malawi. Looking broader, there are also many health systems and population-level influences and drivers on the sample catchment area described above. This is depicted in Figure 2.2 below.

Figure 2.2: Stakeholder mapping of health systems- and population-level influences on the service delivery environment within the catchment area of a typical Malawi health center



There are three main actors at the systems level that have an influence implementation strength within the catchment area through a myriad of connections: the national government (e.g. Ministry of Health), donors and non-government organizations (NGOs), and the District Health Office (DHO). There are issues of harmonization of support for FP between the large donors and the national government. For instance, harmonization of funding and support between these two actors was functioning better in Malawi through a Sector-Wide Approach (SWAp) until the "Cashgate" scandal in 2013, which caused donors to pull resources from the country and divert them into more vertical programs.[52]

There are challenges between the national and district governments that also affect FP service delivery in the CA. The health system of Malawi is fairly decentralized. DHOs have the authority to devise their own district strategic plans and can coordinate with donors and NGOs to support their FP objectives. As mentioned earlier, there is weak financial and HRH capacity across the country. Thus, the donors and NGOs play an integral role in helping to fill gaps in each district. Each DHO has a different level of capacity and leadership ability to manage and coordinate these processes. The District Documentation (see Table 2.1 for more detail) that is part of the parent study describes these types of district-level contextual factors and can inform the downstream results obtained from the ISA.

Cultural norms and politics play a key role in Malawi, as the subject of FP for younger populations can be difficult in a society that is very religious.[55] The national government sets the boundaries for youth FP at the policy level and DHOs must work within this frame. This impacts what kind of FP services can be offered in the CA, such as abortions (which are illegal in

Malawi), and at what age. This situation at the central and district levels likely has an impact on whether an enabling environment is created at the CA level for health workers to effectively deliver FP.

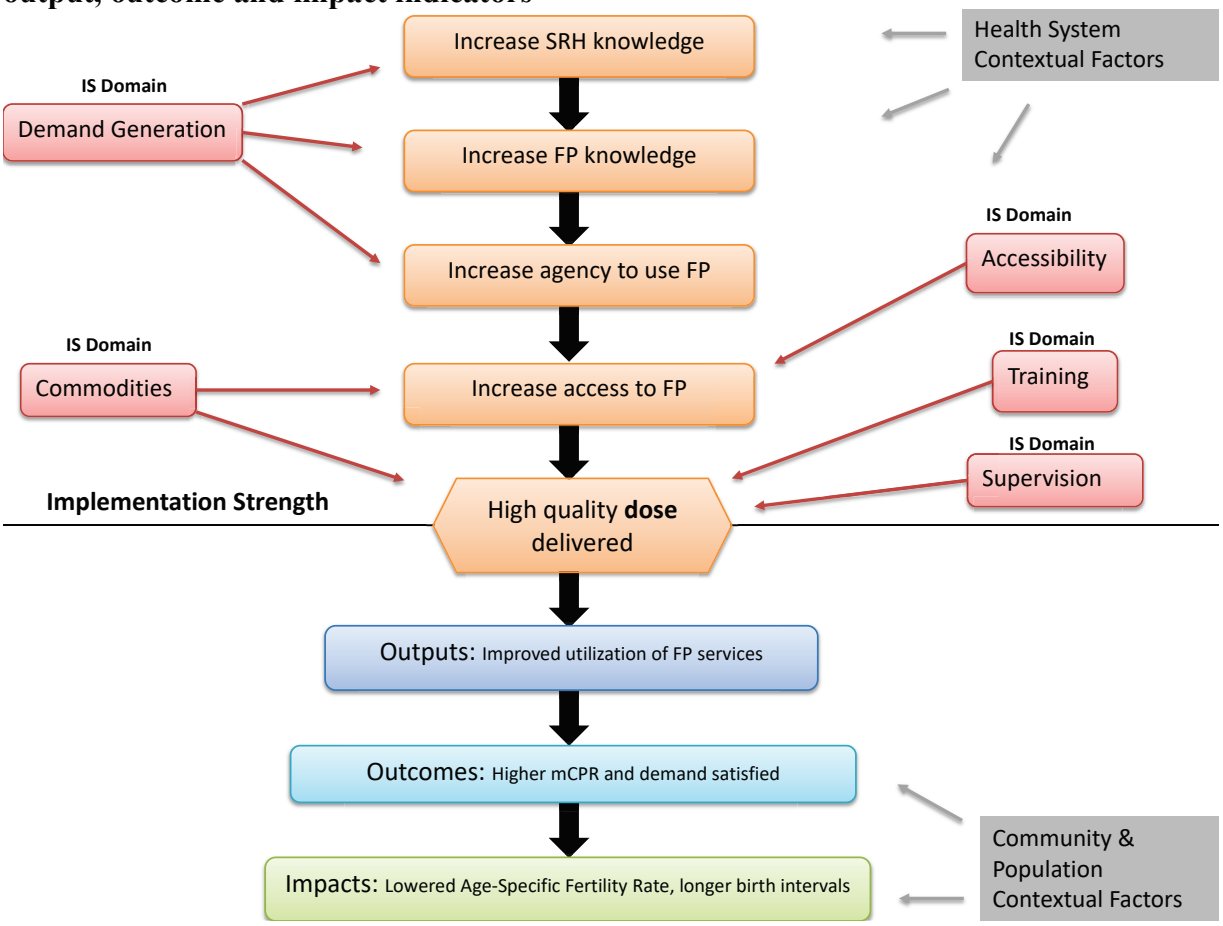
At the population level, there are a number of relationships that can also influence the health workers providing FP within the CA. Pressure from parents, the community, or religious leaders due to cultural norms or religious beliefs can lead health workers to be resistant to providing FP to certain individuals. For instance, a health worker may be hesitant to provide FP methods to a young woman who is unmarried.[61] This type of pressure may be especially difficult for HSAs and CBDAs, as they often reside in the communities they serve and may know the parents of the adolescents that would seek FP. This type of pressure has been shown to be strong on health workers and clients in Malawi.[62,63] Moreover, there are many social norms that influence the health-seeking behavior of youth in Malawi, such as the young age of marriage, expectation of pregnancy shortly after marriage, and lack of female empowerment in their birthing decisions.[55,63,64] The Qualitative study conducted in 2016 that is part of the parent study explored these issues in Malawi among youth and providers and can also inform the ISA results.

Chapter 3: Methodology

Conceptual Framework

Now that the wider picture about what influences a typical catchment area in Malawi has been described, the focus can zoom within the catchment area to what comprises implementation strength of FP programs at the health worker level and the possible effects down the causal chain. Figure 3.1 below provides a depiction of the conceptual framework for this study.

Figure 3.1: Conceptual framework depicting how family planning programs will be assessed for implementation strength and the potential effect on key family planning output, outcome and impact indicators



This figure is based on the common evaluation framework where one can frame evaluation of FP programs in five stepwise domains: 1) inputs 2) processes, 3) outputs, 4) outcomes, and 5) impact.[64,65] The figure above includes all of these domains except 'inputs,' because this research study will not be measuring inputs. In this context, inputs are comprised of the financial, technical, capacity, and other support provided by the national and district government, as well as donors and NGOs in Malawi. The connections between these actors were described in Figure 2.2. These different inputs, or FP programs, in Malawi are involved in one or more of the five major IS domains listed in orange. The District Documentation collected data about these

'inputs' as part of the larger parent study.

The boxes and arrows in the top half of the framework depict how implementation strength is conceptualized in this research. The orange boxes in this top half represent the five major goals described in the ICRW FP framework earlier.[57] To increase uptake of FP services, interventions need to aim to achieve these five goals. The IS domains in red represent these interventions, or 'processes.' These domains feed into the strength of the FP dose delivered to the client, especially the youth. The implementation of these IS processes are primarily influenced by supply-side contextual factors at the health worker, facility, and systems level. These are described in more detail earlier in the Stakeholder Mapping in Figure 2.2.

These five IS domains are linked to each other. The first two domains of training and supervision build and sustain the knowledge, attitudes and practices (KAP) of health workers on providing FP services. For instance, are HSAs routinely trained in Youth-Friendly Health Services (YFHS) and are the skills they are taught in this training sustained via routine supportive supervision? The KAP method has been used extensively in the literature to understand the readiness of health workers to provide FP.[66,67,68]

The next two domains, Commodity Supply and Demand Generation, pertain to the actual FP services that these workers provide to the population. These services include activities to build youth client knowledge, attitudes, and agency to use FP and provision of contraceptive methods. For instance, do HFWs have consistent supply of injectables or do they regularly experience stock-outs? The fifth and final domain of implementation strength is Accessibility. This domain

pertains to how these trained, supervised, and well-supplied health workers who provide FP counseling and methods are deployed in their CAs for easy, private, and reliable access.

Ultimately, what the top half of this framework hypothesizes is that *implementation strength is highest when there is an integrated system in a HF catchment area of well-trained and oft-supervised facility- and community-based health workers who consistently have the commodities and supplies they need to reliably provide contraceptive methods and FP promotion services in a private, confidential manner.*

The bottom half of this conceptual framework theorizes how this combined IS dose from health workers affects the target population. This model theorizes that higher IS of FP programs will have an increase utilization (output). Increased utilization can lead to higher modern contraceptive rate and lower unmet need among women. The model shows that these outcomes are tied to key fertility impacts such as fewer teenage pregnancies and reduced ASFRs. In truth, the evidence for a direct causal link between contraceptive prevalence rates and fertility rates is mixed. Many, such as Robey et al, argue that FP has the most direct influence on fertility, and Cleland et al found that the FP programs in Bangladesh were the main factor for fertility decline in the 1970s and 1980s.[69,70,71] On the other hand, some assert that major drops in fertility have been largely due to lower demand for children.[72] Some even claim that FP programs and contraceptive use play very minor roles in decreasing fertility.[73] Aim 3 explores the associations between IS processes and these FP outcomes in Malawi.

A limitation of this framework is that it is quite linear and lacks the multi-dimensionality of other

implementation research frameworks that take complex adaptive systems into account (for instance). The Stakeholder Mapping described in Figure 2.2 aims to conceptualize these contextual factors that can influence health worker IS in the CA. Still, this conceptual framework fits the more narrow scope of this research. The ISA zooms in on getting a snapshot of IS at the health worker level, rather than exploring the reasons *behind* strong or weak IS. A follow-up study can explore the upstream variables that may affect the IS we are capturing in this study. In fact, some of this will be explored through the other research of the Parent Study, and the 2015/16 Malawi DHS.

Identifying Family Planning Indicators for Malawi ISA

This section provides the methodology of how indicators were chosen for the 'Processes' listed in the conceptual framework above. In order to arrive at the most representative and relevant package of service delivery indicators for a FP ISA, the key theoretical paradigms and frameworks for FP service delivery, common indicators among existing, widely-used tools, and literature and programmatic work that support or contest these indicators were reviewed.

The Bruce/Jain Framework is widely considered the central paradigm for service delivery and quality and the one that major health service delivery assessments are often based upon.[74] Since the publication of this framework, the literature for FP has evolved to demonstrate that the minimum prerequisites for *providing* accessible, quality FP services requires:

- Providers who are trained, have guidelines, and have comfort and desire to provide FP services to all who seek it
- Services that are accessible to the population at static sites and/or through community-

based providers

- Consistent availability of the entire range of contraceptive methods desired
- Providers who receive regular, supportive supervision
- Privacy, confidentiality, and necessary infrastructure at every SDP

More than 700 international FP professionals from 98 countries have identified ten essential elements that contribute to successful FP programs; the relevant supply-side elements are included above.[75] These five elements *do not guarantee* that all who seek FP services when they need them will actually obtain them. However, they do provide a reasonable basis for assuming that services of adequate quality are available to those who seek them. A set of "high-impact practices" was also developed by international experts in FP led by USAID and includes these service delivery elements.[76,77]

Due to the somewhat recent emergence of ISA as a method, there are limited examples of these tools being applied to FP programs.[78] Hence, recent research, programs, and other service delivery evaluation tools were reviewed to substantiate the most relevant FP indicators that could be used in an ISA tool. The four most relevant provider assessments were:

- Quick Investigation of Quality for Clinic-based FP Services (QIQ; Measure Evaluation)
- Situation Analysis Approach to Assessing FP and Reproductive Health Services (SA; Population Council)
- Service Provision Assessment (SPA; USAID/DHS)
- Service Availability and Readiness Assessment (SARA; WHO)

Table 3.1 below compares the common domains for FP service delivery among these tools.

Table 3.1: Data collected through selected provider assessments

	QIQ	SA	SPA	SARA
Deployment		X	X	
Infrastructure	X	X	X	X
HW Training		*	X	*
HW Attitudes	X	X		
Counseling		X		
Supervision	*	*	X	*
Availability of guidelines/protocols	X	**	X	**
Availability of drugs/commodities	X	X	X	X
Monitoring & Evaluation		X	X	
Demand Generation		X		
Integration of Services		X	X	X

*One provider in facility is asked to report on training/supervision for all providers in facility
** Interviewer asks about availability of guidance/tools but does not ask to see them

These assessments all had sections dedicated to 'infrastructure,' 'supervision,' 'availability of guidelines,' and 'availability of contraceptive commodities.' Still, each assessment had different indicators within each of these domains. The 'counseling' and 'demand generation' domains were only included in the Situation Analysis. The next sub-sections describe the indicators within each ISA domain and the rationale behind choosing them.

Provider Training

This domain is comprised of indicators that aim to understand the training that providers delivering FP services have received. These providers can be trained in a range of skills related to FP, from how to provide certain types of contraceptive methods to how to provide youth-friendly health services.[79,80,81] These indicators also solicit information on what skills providers have been trained in and what specific types of providers were trained.[65] The HIV prevention indicator covers HSAs and CBDAs who may have been trained in this topic, which means they have been trained in at least providing condoms and delivering SRH counseling. The other

indicators determine when each type of worker was last trained and how often they received refresher trainings. Table 3.2 describes the indicators for this domain.

Table 3.2: IS indicators for the provider training domain

IS Domain	Sub-Domain	Indicator Definition
Provider Training	Training	Proportion of HWs (e.g. doctors, nurses, CHWs) ever trained in FP provision
		Proportion of HWs trained in FP counseling, condoms, OCPs, injectables, implants, and/or IUDs
		Proportion of HWs ever trained in YFHS
		Proportion of HWs trained in HIV prevention
		Proportion of HWs re-trained in FP provision in the last two years
		Proportion of HWs re-trained in FP YFHS in the last two years

Availability and Provision of Contraceptive Methods and Supplies

This domain captures how available the full range of contraceptive methods desired are at different SDPs. Making sure women have access to the complete range of contraceptive methods is essential for FP program success.[82] For a contraceptive method such as sterilization, only one visit to a facility is needed. However, for more popular shorter-term methods such as condoms, oral pills, and injectables, repeat visits are needed. Thus, it is vital that these methods are *consistently* available and stockouts of commodities are limited or eliminated [14] Cases have shown that some clients choose private facilities over public ones due to a lower chance of stockouts.[3,97,83] A recent UNFPA review of commodity security programs from around the world also reiterated the need for an improvement of commodity availability and supply chains.[84] Contraceptive methods are not the only commodities that need to be evaluated. The availability of key FP supplies should also be assessed at all SDPs.

Table 3.3: IS indicators for the provision of FP methods and supplies domain

IS Domain	Sub-Domain	Indicator Definition
Availability and Provision of Contraceptive Methods and Supplies	FP commodities	Proportion of HWs with each type of commodity available today
		Proportion of HWs with no stockouts of each contraceptive method commonly used by youth in the last 3 months
		Proportion of HWs that had a stockout that lasted more than 7 days
		Proportion of HWs that typically provide 20 condoms per youth client visit
		Proportion of HWs that typically provide 2 month pack of oral contraceptive pills per youth client visit
		Proportion of HWs with FP methods branded with social marketing
	Supplies	Proportion of HWs with any protocols or guidelines specific to FP
		Proportion of HWs with any brochures, visual aids, or other education materials specific to FP
		Proportion of HWs with any protocols or guidelines specific to youth FP

Supervision

While it is important to have trained and equipped providers in key geographical areas, their effectiveness can be affected by whether they are properly supervised. Supportive supervision has shown to be associated with improved services, especially with community-based distribution of FP services.[21] Effective supportive supervision checks performance and emphasizes joint problem solving, mentoring, and two-way communication between supervisors and those being supervised.[85]

While rigorous assessment of provider performance requires observing care and interviewing clients who actually receive their care, supportive supervision is used to assess whether providers are equipped to provide high QoC. The ISA checks supervision plans, the components of supervision visits, and the frequency and consistently of supervision visits.

Table 3.4: IS indicators for the supervision domain

IS Domain	Indicator Definition
Supervision	Proportion of HWs that were supervised in last 3 months for FP by a supervisor at the facility
	Proportion of HWs that were supervised in last 6 months for FP by an external supervisor
	Proportion of HWs that received supervision that included…(use checklist, observe service delivery, discuss performance, inquire about problems, check records, provide suggestions, praise for good work)

Demand Generation & Social Behavior Change Communication (SBCC)

This domain delves into the range of FP counseling practices necessary to share knowledge, generate demand for FP, and change behaviors. This can take the form of awareness building about SRH issues, different types of contraceptive methods, and building agency among the population to use FP services. Counseling can also aid in helping women find contraception more acceptable culturally. For instance, several qualitative research studies have demonstrated how moral and social acceptability of pregnancy prevention are real barriers for women in Kenya and Pakistan.[86,87] A recent review of the effects of FP interventions found that FP counseling and communication with youth is associated with higher utilization.[34]

A consensus is emerging that the provision of accurate information about contraceptive methods and side effects leads to higher mCPR. Other factors such as proximity of actual method provision, social barriers, and affordability have also been linked with higher mCPR.[3] In fact, it has been shown that a well-organized FP program, including substantial information, education, and communication (IEC) component can reduce unmet need by 10 percent and raise use of modern methods of contraceptives by 22 percent.[88]

Social and behavior change communication (SBCC) connotes programs that empower both

individuals and communities to achieve clearly defined FP goals; these can include social marketing through clever advertising, mass media campaigns, m-health interventions, and entertainment education. These SBCC programs have been shown to increase awareness and acceptance of contraception. The literature covers a range of FP counseling and SBCC models that have differential effectiveness, including peer educators and specific types of FP materials (e.g., desired family size).[21,89,90,91] While studies have shown that most women are aware of at least one contraceptive method, there is still considerable, unsubstantiated fear of side effects of certain methods in Malawi. Counseling could help correct these misconceptions.[17] Table 3.5 describes the indicators for this domain:

Table 3.5: IS indicators for the demand generation and SBCC domain

IS Domain	Sub-Domain	Indicator Definition
Demand generation & SBCC	Counseling provided	# of events targeting SRH and FP for youth that HWs have participated in within the last 3 months
		# of alternative spaces that provide information and build skills among youth for FP or HIV prevention that HWs have participated in within the last 3 months
		Proportion of HWs that participated in any hotlines, internet, radio, or mobile technology programs that give SRH and FP info to youth within the last 3 months
	Education/ Awareness building	# of meetings HWs have participated in targeting parents or community leaders regarding youth SRH and FP within the last 3 months
		# of interpersonal agents, reproductive health agents (RHAs), peer educators, or youth CBDAs that HWs that have worked with
		Proportion of HWs that used of mass media interventions (radio, phone, television, internet) within the last 3 months

Accessibility of FP Services

This domain pertains to the availability of health workforce deployed to provide FP services within a specific area. These providers can be doctors, nurses, and other health workers providing FP at a static health facility, or mobile providers such as HSAs or CBDAs. The main

criterion for inclusion is that they actually provide FP services, whether this is in the form of contraceptive commodities or counseling/education. There is widespread evidence suggesting that FP programs that include both knowledge-building components, as well as actual provision of FP contraceptive methods are superior to those that focus on one side.[5]

This domain covers how these providers are deployed; whether in the community or at a static facility, and how many visits they make to a specific area. While most people access their FP needs at static clinics, there is growing evidence suggesting that community-based distribution (CBD) of FP (i.e. task shifting) is effective.[7,92,93,94] Moreover, targeted CBD has been shown to improve utilization of FP by hard-to-reach, youth, and other vulnerable populations.[95,96] A growing body of evidence exists demonstrating the positive effects of injectable and implant distribution by CBD agents on outcomes such as client satisfaction, access, and uptake.[97,98,99]

Privacy is absolutely essential for clients of all ages (especially youth) to feel comfortable discussing and accessing FP.[100,101,102] Conversations about and provision of FP services are very sensitive and require infrastructure that make available private spaces for confidential client-provider conversation.[103] Confidentiality must be maintained both at the static facility and in the community. For instance, utilization will likely be low if youth are accessing FP services from HSAs but feel that their interactions are not private.[104]

Convenience relates to accessibility: specifically, hours of operation, wait times, integration of other required services, and the affordability of services. Curiously, the evidence is mixed for the impact of these variables on reproductive behavior. For instance, studies in Morocco that

evaluated convenience of contraceptive access via different methods (e.g. static facilities, CHWs) found mixed effects on reproductive behavior. While these types of convenience factors didn't appear to predict contraceptive use, they were strong determinants of contraceptive intentions.[105] The evidence does show that more affordable FP services are associated with increased utilization.[106,107,108] Table 3.6 describes the indicators for this domain.

Table 3.6: IS indicators for the accessibility of FP services domain

IS Domain	Sub-Domain	Indicator Definition
Accessibility of FP Services to Youth	Availability	Proportion of HFs who have CHWs that provide FP in the catchment area
		Proportion of HWs who provide FP at least 6 days a week
		Proportion of HWs who provide FP at least 8 hours a day
		Proportion of HWs who provide FP during non-school hours
		Proportion HWs who have conducted mobile outreach in last year
		Proportion YFHS trained HWs living in catchment area
		Proportion of HWs who noted at least 4 strategies to provide FP to youth
	Privacy & Confidentiality	Proportion of HWs who report always finding a space where no can see or hear the interaction when providing FP
		Proportion of HWs who report assuring confidentiality when providing FP
		Proportion of HFs who have a private room for FP consultations

All of the indicators presented above were reviewed for face and content validity. Face validity, as the name suggests, refers to more of an informal assessment of how much a tool subjectively appears to assess what it is supposed to measure (i.e. how does it look at face value?) Content validity is more rigorous as it tests how much a tool or measure represents all the elements of a given construct.[109] Face and content validity of the ISA indicators was evaluated through an exhaustive review of published and gray literature, input from the qualitative study in Malawi, using indicators from vetted assessments already in existence, and by having the tool and

indicators assessed by a set of content experts.[110] A panel of FP experts at the Johns Hopkins Bloomberg School of Public Health and Jhpiego were convened to review the indicators above. Additionally, the indicators were informed by extensive discussions with key leadership at the Malawi Reproductive Health Directorate, National Statistics Office, as well as donors and implementing agencies in Malawi such as BLM, PSI, UNFPA, USAID, and other FP and implementation research experts from the Johns Hopkins Bloomberg School of Public Health and the Population Council. Still, limitations include the number of experts used for this process to identify consensus IS dimensions for FP service delivery and a lack of a formal review process (e.g. Delphi method). This was largely due to resource and time constraints. Also, the literature is limited on defining IS indicators applied specifically to FP programs.

Justification for Mobile Phone Interviews

There were four potential sources of data explored for the FP ISA tool in Malawi. The first two are extraction of existing secondary data sources: (i) routine data and program documentation, and (ii) large-scale surveys. The latter two are primary collection of data sources: (iii) mobile phone interviews or Internet surveys, and (iv) in-person interviews.

Routine data and program documentation

Using existing routine data and program documentation for ISA indicators would be the most cost-effective. These routine data can be obtained from existing M&E, tracking, and reporting systems in Malawi or districts where the ISA is being implemented. Existing DHIS and supply chain systems track what facilities are delivering FP methods, which FP methods are being provided at these facilities, and which facilities are experiencing stockouts in contraceptive

methods in a specified timeframe. In Malawi, a review of the routine data systems found that alone they could not provide reliable and consistent data for the ISA indicators.

Another option that was explored was FP program documentation. This refers to everything from program and policy documents, meeting notes, and program budgets to training and supervision reports and staffing rosters. Information gleaned from documentation can include the context and need for the program, program development and original objectives, actual implementation activities, steps described in an impact model, costs, and contextual factors.[111].

However, there were too many different FP programs being implemented in each district. Trying to obtain records from each implementing actor across these domains would have been time-consuming and difficult. Moreover, bias likely is inherent with a program's own documentation. The District Documentation will gather this type of data from FP Coordinators at each district as part of the parent research. This can supplement ISA data.

Large-Scale Surveys

Several major supply-side assessments in the field were reviewed earlier can be used as data sources for an ISA. The only relevant tool that was conducted in Malawi was the SPA in 2013.[112] While there are sections of this SPA that are useful, such as those assessing the infrastructure of health facilities, there are a few reasons it was not used. First, a more updated cross-sectional snapshot was needed. Second, the SPA is limited to health facilities and largely ignores community-based distribution. Third, the SPA offers little on youth FP.

Mobile/Internet and In-person Interviews

Over the past few decades, technology has evolved quickly; slow, expensive computers have given way to portable devices and landlines have given way to mobile phones that transmit text messages.[113] As the access and utilization of mobile phone and Internet technology spreads across the world, so does the potential for alternative data collection methods. This expansion is not limited to high-income regions. For instance, over 80% of the population in Ghana, Kenya, Tanzania, and Uganda have mobile phone subscriptions.[114]

Research has revealed examples where data for ISA indicators can be collected via mobile phone interviews with relatively high levels of validity. Recently in Malawi, researchers conducted a study testing the validity of collecting integrated community case management (iCCM) indicators through mobile phone interviews to obtain ISA data on HSAs. The study found that the sensitivity and specificity of this method was over 80% for nearly all the ISA indicators, meeting their minimum threshold for validity.[115] While the results of this study support the use of mobile phone interviews in Malawi, this study was specific to iCCM indicators and didn't include HFWs and CBDAs. There are several other examples in the literature for reproductive health specifically that demonstrate the validity of the mobile interview method.[116,117,118] Moreover, the affordability, implementation ease, and the fact that it is less intrusive for the respondent, make mobile phone interviews an attractive option for ISA researchers.[119,120] There has been research that compares the accuracy of mobile phone interviews with SMS and electronic forms and it has found that mobile phone interviews produce the fewest number of errors.[121]

Still, there are limitations. Using mobile phone interviews to administer an ISA tool is predicated on the fact that mobile devices and coverage is available for all survey respondents. There is potential for response bias due to only being able to survey those who can be reached by mobile phone.[122,123] Feasibility of attaining mobile phone numbers or email follow-up call to participants can involve complex administrative logistics. Moreover, not having a trained interviewer in-person that can troubleshoot confusion is a barrier to how complicated survey questions can be. Phone interviews need to be simple, direct, and short. The ISA in Malawi was conducted among health workers with higher literacy rates and likelihood of owning a mobile phone than the general population.

In-person interviews would be appropriate for these more complicated questions. This method gives the researcher the most control, the ability to ask more complicated questions and to resolve any confusion. An even more powerful data collection method for certain ISA indicators could be direct observation of health workers providing FP. However for these two methods, the research team needs to have substantial resources, capacity, and time.

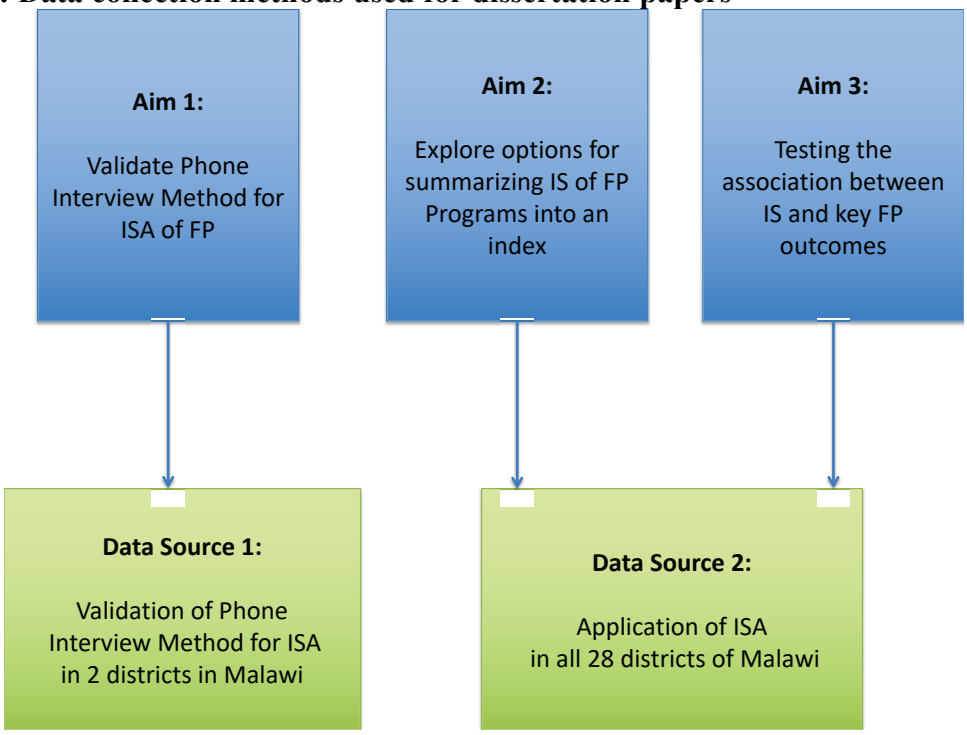
In Malawi, the research team tried to find data collection methods that would be feasible for government agencies, NGOs, and other evaluators to replicate such a study. Conducting short mobile phone interviews was the most cost-effective way to obtain the data needed for the ISA. The complexity of the ISA questionnaire doesn't allow for the SMS option and the lack of Internet connectivity demotes the Internet survey option. Moreover, Malawi has a high saturation of mobile phone use across all 28 districts and due to how mobile services function in Malawi, health workers do not incur any cost for receiving calls. Aim 1 of this research tested

the validity and feasibility of using the phone method to collect IS data.

Methods of Data Collection

This section will discuss the two primary data sources that were used for this research. The first is the validation of the mobile interview method for assessing IS of FP programs in two districts in Malawi. This cross-sectional study was conducted in May 2017. The second is the application of the Implementation Strength Assessment for FP in all 28 districts of Malawi. This cross-sectional study was conducted in July 2017.

Figure 3.2: Data collection methods used for dissertation papers



Validation of the Mobile-Based Method for Assessing Implementation Strength of Family Planning in Malawi

Study Design

The objectives of this validation study were to: (i) to determine whether mobile phone interviews with health workers delivering FP is a feasible approach for measuring FP IS indicators and produces valid estimates of strength; (ii) to pre-test the ISA in two districts to test the feasibility of the operational process; (iii) to identify IS indicators that are suitable for measurement through this approach in Malawi.

The analysis section for this validation will explain how feasibility and validity was measured. The latter two objectives serve the purpose of determining how the tool and data collection method performs in this context and what adjustments need to be made to increase its fit, which is a common step for implementation research studies.[38,124]

In order to reach these objectives, phone interviews were conducted with the three cadres of health workers delivering FP to youth in Malawi. These health workers were interviewed using a structured questionnaire to collect data on the five IS domains. Responses received via mobile phone were validated through training, supervision, and monitoring records and inspections of drug/supply stocks at the village clinic (where HSAs and CBDAs work).

A key limitation was using the health worker records and observation as the "gold standard" to test for sensitivity and specificity with the phone interview. These records and observations can serve as a source of potential bias. First, these records themselves are subject to reporting bias. There is also the risk that these records are not complete across every facility and village clinic in these two districts, and thus will not allow for a comparator to the phone responses. Other options, such as continuous monitoring of a group of health workers for a period of time, were

explored but were not feasible. Thus, verifying provider phone interview responses with their records and in-person observations was the only practical option for validation.

Sample size calculation

The validation study required a sample large enough to detect significant differences between the mobile phone and in-person methods. A sample size of 138 for each cadre was calculated using Kappa statistic calculations (which is often used in other validation studies) with 95% confidence levels.[125,126] The approximate prevalence used was for the "proportion of providers experiencing any stock-outs in the last 3 months" indicator, which the research team felt was the most important IS indicator. The approximate prevalence of stockouts is 50% (the most conservative estimate). The Kappa statistic used for the level of agreement is 80%, though LOA values over 60% indicate good agreement in the literature.[127] Calculations were also made using sensitivity and specificity, but we used the more conservative sample size estimate.

This research was conducted in the Dowa and Ntcheu districts of Malawi. These districts were chosen primarily because of their close proximity to Zomba, where all the mobile phone interviews will be conducted. We also had an accurate list of all the health facilities in both districts. We interviewed all the In-Charges from every health facility that provide FP in these two districts. Lists of health workers who provide FP and their phone numbers were obtained from the initial Health Facility In-Charge interview. For the phone interview phase, the study team contacted all of these health workers to mimic the Full ISA. For the in-person validation phase, we randomly selected and followed up with providers from each facility to reach the minimum sample size (138) for each cadre.

Data Collection

Data collection for the validation study took four weeks starting in May 2017 after a week of training. Six interview teams with five interviewers in each conducted the phone interviews and in-person verification checks. Each team was assigned a certain number of total interviews. The survey management team and each supervisor had to consistently check data for quality and carefully planned the in-person visits. Interview teams worked six days per week until all data had been collected.

The first step was for each team to call the health facility In-Charge from a full list of the two districts to elicit basic information about that health facility, including the names and contact information of HFWs, HSAs and CBDAs that provide FP via that facility. From this, the study team enumerated and obtained the telephone numbers for all health workers providing FP in both districts. Then, the interviewers called these providers and used the structured survey.

Once all mobile phone interviews are completed (in 10-11 days), the interview teams conducted the in-person validation interviews. Teams were sent to districts to introduce themselves, then to health facilities with letters authorizing the data collection exercise. Provision registries, training and supervision records, and drug stocks were checked both at the health facility and the individual records of HSAs and CBDAs. If any discrepancies were found between HSA/CBDA records and the corresponding records at the health facility, the respondent was asked additional open-ended questions about the reason for this discrepancy. These discrepancies and the results of this interview were not be shared with the facility In-Charge.

Implementation Strength Assessment in remaining 26 Districts of Malawi

Study Design

The objectives of this larger ISA data collection were to: (i) to get estimates of the IS indicators for FP programs at the health facility catchment area level; (ii) to ascribe IS measures to each catchment area in Malawi.

In order to do reach these objectives, implementation followed the procedures of the phone interview phase of the validation study described earlier. Any changes to the survey tool or process stemmed from lessons learned during the validation. There was no field-based data collection. The data collected from this study was utilized for both Aim 2 and Aim 3.

Sampling

This study was conducted in 27 districts, not including the two from the Validation study. The sampling frame for this study included all Government Health centers and hospitals, Christian Health Association of Malawi (CHAM) facilities, BLM and FPAM static clinics across all districts in Malawi. These facilities were primarily chosen because the Malawi government had contact information for these; other NGO and private facilities make up a very small proportion of all facilities in Malawi (<5%). There are a total of 666 health facilities across Malawi in our sampling frame, though some districts have as little as four health facilities and the more urban ones with as many as 141. There are a total of 4860 HSAs providing FP across Malawi according to the local commodity supply chain system. The average HSAs per facility in each district ranges from 2.5

to 13.5 with a median of 6.1. This variation in HSAs per facility may be even higher at the individual facility level. According to RHD estimates, the total number of CBDAs across Malawi totals 3430. The average CBDAs per facility in each district ranges from 2.6 to 18.6 with a median of 4.7. This variation in CBDAs per facility may be even higher at the individual facility level. There is no census listing with contact information of all the CBDAs in each district. Thus, the interviewers contacted the In-Charges to obtain the phone number of the CBDAs associated with its facility.

There were two options explored for sampling each cadre of health worker to obtain a representative sample in each district. The first option was by simple random sampling (SRS) each worker type in each district. We would need to obtain a census of each type of health worker in each district to serve as a sampling frame. The second option is to obtain these samples via multi-stage sampling. This would mean conducting a simple random sample of health facilities in each district, and then from the facilities selected, randomly sample associated HSAs, and CBDAs. For this option, the facility would be treated like the household and HSAs and CBDAs would be treated as household members. The benefit of this approach is that achieves more granular, geographic precision of IS. However, the drawback to this approach is that increases the sample size due to the design effect. This can put pressure on limited capacity and budget for this project.

A certain number of interviews could be avoided if a SRS sampling method was adopted. Also, any design effect multiplier that would account for clustering in a multi-stage sample would necessitate sampling more health workers than currently exist in some districts. While the SRS

option does save the research team from conducting extra interviews, it would significantly delay the interview process because all of the contact information of each health worker in the district would need to be determined to complete the sampling frame before the next step of calling individual health workers could start. In order to avoid this delay and because the project has the capacity to include the extra interviews, the research team decided to attempt to call all health workers providing FP associated with public and NGO facilities across Malawi.

Data collection

The process used for the phone interview phase of the validation study was replicated except for the field-based validation visits, which did not occur. Lessons learned in data collection and operational logistics and management from the validation were applied to this ISA process.

Data collection for the ISA census took about 6 weeks starting in mid-July after interviewers and supervisors were trained. Twelve interview teams of 5 each, for a total of 60 local interviewers, conducted the phone interviews at the NSO headquarters in Zomba. Each team was assigned a supervisor and a certain number of total interviews. The supervisor carefully assigned and tracked data collection and consistently checked interviews and data for quality.

Ethical Clearance

The Johns Hopkins School of Public Health Institutional Review Board and the Malawi National Health Science Research Committee approved the validation and the Full ISA phases in April 2017. Verbal informed consent was obtained from all study participants. There was no monetary compensation or costs for participants. Confidentiality of participants was protected and

information on participants was only available to the study team.

Methods for Data Analysis

This section will review the analyses that were conducted for each research aim. The first describes what specific IS indicators were used for this validation comparison and how validity was assessed by comparing the mobile phone responses to the in-person ones. The second explored options for how to summarize the results of the ISA across all 28 districts of Malawi into an index that represents IS at the health facility catchment area level. The third aim tested how this IS summary measure may be associated with key FP outcomes.

Assessing whether mobile phone interviews are a valid and feasible method to measure implementation strength of family planning programs (Aim 1)

This analysis sought to validate the IS data collected via mobile phone interviews by focusing on the sensitivity and specificity of the responses collected through mobile phone interviews with the information obtained through visits to the associated health center or village clinics. The ultimate purpose is to demonstrate that practitioners can use this rapid, highly feasible m-Health method to routinely collect data for an ISA.

How well does the mobile phone measurement of ISA indicators match in-person measurement using record checks and observation? Testing the sensitivity of a data collection method allows one to understand the proportion correctly classified by the surrogate method compared with a gold standard method. Specificity allows one to understand the proportion correctly identified as

NOT having the attribute compared with a gold standard measure. As described earlier, the gold standard measure here is in-person verification, even though it was acknowledged earlier that these records could contain errors or be incomplete.

An example of calculating sensitivity in this study is comparing those who self-reported (via phone interview) being trained in YFHS with those who actually have been trained in YFHS, according to the gold standard method of in-person inspection of health worker records. Specificity here is defined as those self-reporting as not being trained in YFHS out of those who are actually not trained in YFHS, according to the gold standard method.

Not all the indicators in the ISA tool could be validated due to limitations on what data are able to be collected via inspection visits. The table below describes those that were evaluated.

Table 3.7: Key Implementation Strength indicators and how they will be validated

Implementation Strength Indicator	HW Type	Validation method	Description
(1) Conducted mobile outreach in last year	HSA, CBDA	Monitoring or Supervisor Records	Review of register records at VC or supervisor records at HF for last year
(2) Conducted youth events in last 3 months	HSA, CBDA	Monitoring or Supervisor Records	Review of VC records or supervisor records at HF for last 3 months
(3) Have family planning Guidelines	IC, HSA, CBDA	Observation at HF or VC	Direct observation on site
(4) Provide oral contraceptive pills (OCPs)	HSA, CBDA	Observation at HF or VC	Direct observation on site
(5) OCPs available on day of interview	HSA, CBDA	Observation at HF or VC	Direct observation on site
(6) Had an OCP stockout in last 3 months	HSA, CBDA	Register Review	Review of register records at VC for previous 3 months
(7) Provide injectables	IC, HSA	Observation at HF or VC	Direct observation on site

(8) Injectables available on day of interview	IC, HSA	Observation at HF or VC	Direct observation on site
(9) Had an injectable stockout in last 3 months	IC, HSA	Register Review	Review of register records at HF or VC for previous 3 months
(10) HFs who received supervision that included FP from someone external to the HF in previous 3 reporting months	IC	Supervision records	Review of register or supervisor records at HF for previous 3 months
(11) HFs who supervise their HWs with reinforcement of YFHS practice	IC	Observation at HF	Direct observation on site
(12) HFs whose supervision checklist of HWs includes Youth FP	IC	Observation at HF	Direct observation on site
(13) HFs with Youth FP guidelines or protocols	IC	Observation at HF	Direct observation on site
(14) HFs with FP pamphlets	IC	Observation at HF	Direct observation on site
(15) HFs that provide implants	IC	Observation at HF	Direct observation on site
(16) HFs with current stocks of implants	IC	Observation at HF	Direct observation on site
(17) HFs with no stock-out in the last 3 reporting months of implants	IC	Register Review	Review of register records at HF for previous 3 months
(18) HFs have private room for FP consultations	IC	Observation at HF	Direct observation on site
(19) HFs have space designated for youth consultations & activities	IC	Observation at HF	Direct observation on site

As can be seen in Table 3.7 above, each indicator is divided into three health worker cadres. Thus, there are several indicators within the five IS domains that were validated across all three provider types. The validation methods used include FP registry, training, supervisory, and monthly monitoring records kept at the health center and at the village clinic. The other validation method used is direct observation at these health centers and village clinics. Consistent availability of these records was tested in this validation study.

The first step of the analysis was to explore the data for errors, missing values and use graphical techniques to visualize the data to understand key characteristics of each variable, such as its dispersion and outliers. The second step was to analyze the background demographics of the health workers interviewed. The third step will be to review the results of the sensitivity and specificity tests described in the previous section.

A limitation is that verification can only occur if health worker records are not missing. If records were missing during in-person visits, than these data were excluded. If the respondents answered that they "do not know" for any of the indicators above, then this data were categorized as wrongly classified data and still used to determine sensitivity and specificity.

Once sensitivity and specificity of each indicator above was ascertained, each one was reviewed for practical use. Using previous studies as a guide, we set the threshold for adequacy is a sensitivity and specificity above 70%.[115] Thus, the objective was for each indicator above to have above 70% sensitivity and specificity in order to conclude that the mobile phone method produces accurate information. Changes were made to the survey questions if it was clear from the validation that discrepancies were occurring due to common reasons, such as not understand certain terms (e.g. mobile outreach) or date ranges (e.g. past 3 months).

Exploring and comparing options for summarizing implementation strength scores across domains and health system levels (Aim 2)

Using the 2017 Malawi ISA data, this analysis explored four methods that combine across IS domains and indicators, as well as two methods that combine across health worker and health

facility data to construct IS scores for each health facility's catchment area. This analysis will also compare how well each method captures variation in the data and assign implementation strength scores at different levels. As discussed earlier in the conceptual framework section, the most important level of analysis for implementation strength is at the catchment area of a specific health facility, where the combined IS from the three different health worker cadres working together can be analyzed.

The entire indicator list for the Malawi ISA is listed in Table 3.8 below. This table also indicates the specific indicators for which HW types were surveyed.

Table 3.8: ISA indicators for health facility and health worker cadres, by IS domain

ISA Indicator - n (%)	Facility (via IC)	Health Worker Type		
		HFW	HSA	CBDA
Training of Health care Workers				
Trained in all methods* in the prior two years	-	+	+	+
Ever trained in YFHS	-	+	+	+
Supervision				
Has supervision checklist that includes Youth FP	+	-	-	-
Supervised for FP in prior 3 months**	-	+	+	+
Last supervision covered youth FP topics	-	+	+	+
Contraceptive Methods and Supplies				
Provides all FP methods*	+	+	+	+
All FP methods* available on day of interview	+	+	+	+
Has FP guidelines and job aids	+	+	+	+
Has youth FP guidelines	+	+	+	+
Provides FP methods branded with social marketing	+	+	+	+
Demand Generation Activities				
Conducted youth event in prior 3 months	+	+	+	+
Conducted SRH talks in prior 3 months	-	-	+	+
Conducted youth spaces in prior 3 months	+	+	+	+
Conducted community meetings in prior 3 months	+	+	+	+
Facility has peer educators for FP	+	-	-	-
Accessibility				

Has special days for youth FP	+	-	+	+
Conducted mobile outreach in prior 6 months	+	-	+	+
Ensures privacy during FP consultations***	+	+	+	+
Provides FP the minimum hours per week ****	+	-	+	+

*Appropriate to HW type. HFW: counseling, condoms, OCP, injectables, implants; HSA: counseling, condoms, OCP, injectables; CBDA: counseling, condoms, OCP
**For facilities this is by someone external to the facility
***For facilities, must have a private room
***For facilities: ≥24 hours/week of access. For CBDA/HSA: ≥12 hours/week of access.

The table demonstrates how many of the indicators are divided into two parts: one for FP provision to all clients and another for FP provision specifically to youth clients. The first step once the data are collected was to explore to check for any missing data for each of the indicators listed above. Data were explored for outliers, ranges of each of the variables, as well as using visual depictions such as histograms and boxplots. Once the data from both the validation study and larger ISA were cleaned, the data were combined into a dataset that represented all of the IS data across the 29 districts of Malawi.

For aim 2, the next step in creating an IS score was to transform the raw data collected to IS indicators. Thus, the data from this full dataset was transformed to the indicators per HW type as presented in Table 3.8 above. All indicators were coded as either 1 (if yes) or 0 (if no). After transforming the raw data into indicators, we then tested different methods to (i) combine indicators within and then across domains (4 methods); (ii) combine data across health facility (IC and HFW) and community health worker (HSA and CBDA) levels (2 methods) to create a catchment area-level IS summary score for each health facility in Malawi. The four methods we explored for combining data across domains were two additive ones, simple and weighted, as well as two factor analyses, a principal components analysis (PCA) and an exploratory factor analysis (EFA). The two methods to combine across health system levels were a simple average model and a Bayesian mixed effects model. The final step in this analysis compared how well

these methods captured variation in IS by comparing score distributions using a variety of plots, model fit, intra-class coefficient, and other methodologies. Index scores were also compared in how they predicted couple-years protection (CYP), which estimates the amount of protection provided by FP services over the course of a one-year period based on the volume and type of modern contraceptives provided. Chapter 5 provides more details of how these methods were constructed and used. This analysis was conducted using R version 3.4.1 software.

Testing the association of implementation strength of FP programs with key family planning outcomes in Malawi (Aim 3)

This research aim tested the association between catchment area-level scores from the recommended IS index from Aim 2 and modern contraceptive use among rural women within those catchment areas in Malawi. The data source for modern contraceptive use was the 2015/16 DHS collected in Malawi. The DHS defines modern contraceptive use as any woman using male condoms, female condoms, oral contraceptive pills, injectables, implants, IUDs, male and female sterilization, and emergency contraception at the time of interview.[55] This indicator was chosen because it is routinely used in assessments of FP coverage and represents a measure that is an explicit goal of Malawi's FP programs.[49] Due to the fact that a key objective of this research is to develop a validated ISA tool and that this is the first application of this ISA, this aim will assess the criterion validity of IS and its connection to contraceptive use.

A recent review of the literature by Durlak et al found evidence that strongly supported a significant positive relationship between level of implementation and program outcomes.[38] For instance, a large meta-analysis that conducted a regression analysis between 221 school-based

prevention programs targeting aggressive behaviors found that implementation was the most important feature that influenced outcomes.[128] A recent study by John Ross (2015) provided further support for this in FP. Ross demonstrated that stronger implementation of FP programs (measured by a Family Planning Program Effort index) reduced gaps in contraceptive use in 46 low and middle-income countries, including those in sub-Saharan Africa.[129]

The index scores created in Aim 2 analyze IS at the facility catchment area level. In order to link modern contraceptive use among women within those catchment areas, a method developed by Peters et al in 2017 was employed. This method creates 5 km buffers around DHS cluster centroids and identifies the health facility catchment areas that fall within these buffers. Using this method, each DHS cluster has an average IS score associated with it. Peters et al developed this technique using the 2017 Malawi ISA data. Thus, Aim 3 uses this technique to test the association between the IS score and women using modern contraceptives within each cluster using a mixed effects model that accounts for fixed and random effects. The outcome was the odds of whether a woman is currently using a modern contraceptive. The fixed effects were the IS score and key control variables (e.g. age, education, wealth, etc), while random effects account for clustering at the district level. Stepwise regressions were performed to explore the influence of control variables and key interaction terms. More detail on this analysis can be found in Chapter 6. All analysis was conducted using R 3.4.1 software.

Chapter 4: Testing the Validity of Using a Mobile Phone-Based Method to Assess the Strength of Implementation of Family Planning Programs in Malawi

Background

Providing family planning is shown to be one of the most effective ways of decreasing maternal mortality, reducing population growth, and ensuring all women have the ability to choose when to have a child.[2,5,7,130] The Sustainable Development Goals (SDGs) underline this point at a global level by recommending several key family planning (FP) indicators.[30] Between 1990 and 2015, modern contraceptive prevalence rates (mCPR) have increased from 54.8% to 63.3% worldwide, resulting in decreasing fertility rates, and contributing to increases in child survival around the world.[4,131]

However, mCPR has only increased to around 40% in the Sub-Saharan African (SSA) WHO region, which affects the outcomes further down the causal chain.[20,21,132] In response, governments and NGOs in several SSA countries have increased their emphasis on FP programs.[133,134] Malawi, a small, but densely populated, largely rural SSA country with a population of 14 million in 94,280 sq km has prioritized FP over the past decade.[49,53] In particular, the government has emphasized targeting the youth of the country through programs, highlighted by a Youth-Friendly Health Services (YFHS) strategy started in 2007 that was designed to guide programs at both health facility and community health worker levels.[58]

One major challenge for governments in Malawi and in many other lower and middle-income countries (LMICs) that have major financial, infrastructure, and human resource challenges is understanding how their FP programs are actually being implemented. The Real Accountability: Data Analysis for Results (RADAR) project, which is part of the International Institute of International Programs (IIP), developed a suite of tools that can assist in these types of

evaluations in LMICs.[135] One RADAR tool, the implementation strength assessment (ISA), rapidly evaluates the quantity or dose of a program delivered to its target population and has been applied in a number of contexts.[64,74,115,136]

Another common challenge in LMICs is the lack of quality data that is routinely collected at the national, district, facility, and health worker levels. This data is essential for any evaluation of program implementation, such as an ISA. Moreover, primary data collection at any of these levels for this type of evaluation can be labor and cost-intensive when using traditional, in-person data collection methods. Studies have shown that mobile phone interviews can be a cost-effective method to collect simple, quantitative data and due to the fact that mobile phones are becoming increasingly saturated in SSA.[115,114 ,121,122] In order to test whether this is the case for conducting an ISA, we collected data via mobile phone and in-person interviews in Malawi and tracked the costs associated with phases in order to compare the cost-per-interview of each.

Due to the fact that the ISA largely focuses on the structural quality of a health system, we collected data from three sets of workers that provide FP in Malawi.[154] At the facility level, In-Charges (ICs) manage the health facility and thus can provide IS data for that facility. At the community level, HSAs are salaried by the Malawi government and provide condoms, oral pills, and injectables, while voluntary CBDAs provide condoms and oral pills in the community. Each HSA and CBDA is connected to their nearest facility, where they are supposed to regularly receive supervision and FP commodities.

The objective of this study is to test the validity and feasibility of collecting ISA data via mobile phone interviews at the health facility and CHW levels in a low-income country. As mobile phone saturation increases even in LICs, this study can add to the existing evidence on the benefits and costs of using this technology to collect IS or QoC data on FP, especially among workers at different levels of the health system.[20,44,120,137] If the phone method is shown to be valid and feasible, then these types of assessments can be done more routinely by governments and NGOs in LMICs interested in rapidly understanding how strongly their FP programs are being implemented.

Methods

We developed an ISA instrument for FP after an extensive literature review and expert consultation on indicators and domains, and as part of NEPs larger objective to develop instruments to evaluate public health programs worldwide.[135,138] The instrument evaluates the implementation strength of Malawi's FP programs across five domains of training, supervision, contraceptive method availability, demand generation activities, and accessibility. A more in-depth description of the instrument can be found in Chipokosa et al and the Annex.[153]

The target population was ICs, HSAs, and CBDAs that provide FP in the districts of Dowa and Ntcheu in Malawi. We chose these districts for convenience; they are within 100 and 300 km of Zomba, the town in which phone interviews were conducted. Additionally, the number of workers was sufficient for comparison of phone vs. in-person methods of data collection.

We worked in partnership with Malawi's National Statistics Office (NSO), which recruited,

trained and oversaw data collection. NSO deliberately recruited younger data collectors who would be more familiar and adept at using mobile phones and tablets. Data collection took place in May 2017 after a week of training experienced data collectors. Interviewers were given a mobile phone, headset, and a tablet for data collection. Interviewers were also given airtime daily for their mobile phones according to the number of calls they needed to complete that day. Quality assurance checks at the supervisor and survey management team levels were designed to consistently check data collection for quality and carefully plan and implement the phone interviews and in-person visits.

We conducted phone-based and subsequently identical field-based data collection. Responses received via the phone interview were subsequently validated through in-person review of training, supervision, and monitoring records and inspections of supply stocks. See Table 4.1 for details on each IS indicator and validation methods.

Table 4.1: Description of study validation methods

Implementation Strength Indicator	HW Type	Validation method	Description
(1) Conducted mobile outreach in last year	HSA, CBDA	Monitoring or Supervisor Records	Review of register records at VC or supervisor records at HF for last year
(2) Conducted youth events in last 3 months	HSA, CBDA	Monitoring or Supervisor Records	Review of VC records or supervisor records at HF for last 3 months
(3) Have family planning Guidelines	IC, HSA, CBDA	Observation at HF or VC	Direct observation on site
(4) Provide oral contraceptive pills (OCPs)	HSA, CBDA	Observation at HF or VC	Direct observation on site
(5) OCPs available on day of interview	HSA, CBDA	Observation at HF or VC	Direct observation on site
(6) Had an OCP stockout in last 3 months	HSA, CBDA	Register Review	Review of register records at VC for previous 3 months

(7) Provide injectables	IC, HSA	Observation at HF or VC	Direct observation on site
(8) Injectables available on day of interview	IC, HSA	Observation at HF or VC	Direct observation on site
(9) Had an injectable stockout in last 3 months	IC, HSA	Register Review	Review of register records at HF or VC for previous 3 months
(10) HFs who received supervision that included FP from someone external to the HF in previous 3 reporting months	IC	Supervision records	Review of register or supervisor records at HF for previous 3 months
(11) HFs who supervise their HWs with reinforcement of YFHS practice	IC	Observation at HF	Direct observation on site
(12) HFs whose supervision checklist of HWs includes Youth FP	IC	Observation at HF	Direct observation on site
(13) HFs with Youth FP guidelines or protocols	IC	Observation at HF	Direct observation on site
(14) HFs with FP pamphlets	IC	Observation at HF	Direct observation on site
(15) HFs that provide implants	IC	Observation at HF	Direct observation on site
(16) HFs with current stocks of implants	IC	Observation at HF	Direct observation on site
(17) HFs with no stock-out in the last 3 reporting months of implants	IC	Register Review	Review of register records at HF for previous 3 months
(18) HFs have private room for FP consultations	IC	Observation at HF	Direct observation on site
(19) HFs have space designated for youth consultations & activities	IC	Observation at HF	Direct observation on site

First, a list of ICs and their mobile phone numbers was compiled from the two districts. Interviewers then called them to elicit basic information about that health facility and its workers, including workers' contact information. Then interviewers conducted phone interviews with all of the health workers identified by the ICs.

Once all phone interviews were completed (in 10 working days), the interview teams conducted

the in-person validation interviews. All In-Charges were interviewed and HSAs and CBDAs were randomly selected from each facility in-person data collection. During field visits, health facility and community service provision registries, training and supervision records, and drug stocks were reviewed. Discrepancies in phone interview and in-person responses were flagged and in response, the interviewer asked the worker structured qualitative questions about the reason for this discrepancy.

This study required a sample large enough to detect significant differences between the mobile phone and in-person methods. We calculated a sample size of 138 for each cadre using Kappa statistic calculations (which is often used in other validation studies) with 95% confidence levels.[139,140] The approximate prevalence used was for the "proportion of providers experiencing any stock-outs in the last 3 months" indicator, which the research team felt was the most important IS indicator. The approximate prevalence of stockouts is 50% (the most conservative estimate). The Kappa statistic used for the level of agreement (LOA) is 80%, though LOA values over 60% indicate good agreement in the literature.[141] All health workers, not just the sampling minimum of 138, were targeted for the mobile phone interview phase because this data would be used for the larger research study which collected ISA data from all health workers who provide FP across the remaining 26 districts in Malawi.

Following data collection, sensitivity and specificity was calculated by comparing the responses from the phone interviews to the inspection visits. This analysis was done separately for the ICs, HSAs, and CBDAs. In this analysis, the inspection visits were treated as the gold standard. We established 70% as the criterion for considering the mobile phone responses adequate for the

ISA. All the analyses reviewed above were conducted using R version 3.4.1 software.[178]

Feasibility

This study also compared the feasibility of collecting ISA data using the mobile phone versus in-person methods. This was done by comparing the costs associated with the mobile phone interview phase versus the costs associated with the in-person inspection phase. Key costs include the airtime used for phone interviews, equipment costs such as mobile phones and sim cards for two Malawian networks, transportation costs for in-person interviews, and other management costs, such as interviewer and supervisor per diems. Ultimately, we aimed to compare cost-per-interview using mobile phones versus in-person inspections.

The Johns Hopkins Bloomberg School of Public Health Institutional Review Board and the Malawi National Health Science Research Committee approved the ISA validation study in April 2017. Verbal informed consent was obtained from all study participants. No compensation was provided for participants.

Results

We interviewed all 59 (100%) In-Charges that manage the hospitals and health centers in the districts of Dowa and Ntcheu both on the phone and in-person. Phone interviews were conducted with 529 (96%) HSAs on the phone and 188 (35%) in-person and with 113 (97%) CBDAs on the phone and 109 (94%) CBDAs in-person. The proportion of total HSAs selected for in-person interviews is low because these workers were randomly selected to meet the minimum target sample size.

Three facilities reported not providing FP and were not interviewed further. The number of CBDAs actually working in both districts was less than what was estimated prior to data collection. Table 4.2 provides an overview of the data we collected.

Table 4.2: Health facilities and HSA/CBDA population, selection and interviewed/data collected

	Dowa	Ntcheu	Total
Target Population			
HFs	22	37	59
HSAs	344	207	551
CBDAs	32	85	117
Interviewed on phone			
HFs	22	37	59
HSAs	331	198	529
CBDAs	29	84	113
Validation Interview in-person			
HFs	22	37	59
HSAs	95	93	188
CBDAs	26	83	109

Table 4.3 below shows the background characteristics of the CHWs interviewed for this study. On average, the HSAs were older (37.8) than the CBDAs (33.6) and a larger proportion of HSAs are male (58.7 versus 43.8). Over 92.3% of HSAs versus 76.1% of CBDAs are married and nearly 64% of HSAs have at least a MSCe, compared to only a quarter of CBDAs. More than half (53.6%) of all CBDAs interviewed started working in their catchment area since January 2016, while only 5.5% of HSAs started since in January 2016.

Table 4.3: Background characteristics of CBDAs and HSAs interviewed on the phone in Dowa and Ntcheu districts in Malawi

	HSA	CBDA
n	529	113
Age (mean (sd))	37.80 (6.77)	33.66 (9.75)

Gender = Male (%)	291 (58.7)	49 (43.8)
Religion (%)		
Catholic	99 (20.7)	28 (25.0)
Non-Catholic Christian	334 (69.7)	71 (65.2)
Other	46 (9.6)	11 (9.8)
Marital status (%)		
Married	443 (92.3)	83 (76.1)
Separated/divorced	15 (3.1)	7 (6.4)
Single	21 (4.4)	14 (12.8)
Education level (%)		
Primary School Living Certificate	8 (1.6)	39 (34.8)
Secondary School Junior Certificate	157 (31.7)	44 (39.3)
Secondary Malawi School Certificate of Education (MSCe)	316 (63.7)	28 (25.0)
Year starting in catchment area (%)		
Before Jan 2016	468 (94.5)	42 (46.4)
Since Jan 2016	27 (5.5)	60 (53.6)

Table 4.4 below provides an overview of the reported and observed percentages, as well as the sensitivity and specificity, for the health facility IS indicators. Sensitivity for phone reporting for the supervision indicators was above the threshold for external supervision (80%), YFHS supervision (100%), and supervision checklist that includes youth topics (75%). However, specificity for each of these indicators was below the threshold (50%, 66%, and 31% respectively).

Indicators pertaining to FP supplies showed the same pattern; sensitivity for having FP guidelines was 96%, having youth FP guidelines was 73%, having FP job aids was 94%, and having FP pamphlets was 89%. Yet, specificity for these indicators was well below the threshold at 13%, 52%, 25%, and 50% respectively.

Table 4.4: Implementation strength indicators reported by the In-Charges versus observed by the interviewers with sensitivity and specificity of the IC phone interview method (weighted)

Implementation Strength Indicator	Reported percentage (n/N)	Observed Percentage (n/N)	Sensitivity (%)	Specificity (%)
HFs who received FP supervision from someone external in previous 3 months	73 (38/52)	77 (40/52)	80	50
HFs who supervise their HWs with reinforcement of YFHS practice	49 (18/37)	22 (8/37)	100	66
HFs whose supervision checklist of HWs includes youth FP	69 (25/36)	89 (32/36)	75	31
HFs with FP guidelines	94 (50/53)	85 (45/53)	96	13
HFs with youth FP guidelines	57 (31/54)	45 (24/53)	73	52
HFs with FP job aids	86 (44/51)	61 (31/51)	94	25
HFs with FP pamphlets	75 (39/52)	73 (38/52)	89	50
HFs that provide				
Injectables	96 (51/53)	96 (51/53)	100	100
Implants	88 (45/51)	96 (49/51)	95	100
HFs with current stocks of				
Injectables	96 (49/51)	96 (49/51)	100	100
Implants	74 (39/53)	77 (41/53)	100	67
HFs with no stock-out in the previous 3 reporting months of				
Injectables	88 (45/51)	96 (49/51)	100	92
Implants	87 (34/39)	92 (36/39)	67	92
HFs that have a private room for FP consultations	91 (48/53)	89 (47/53)	94	33
HFs have a space designated for youth consultations and activities	13 (7/53)	21 (11/53)	45	95

The FP commodity indicators demonstrated higher sensitivity and specificity. The providing injectables indicators demonstrated sensitivity and specificity of 100%, while providing implants was 95% and 100% respectively. Sensitivity and specificity was 100% for the indicator of whether injectables were available on the day of the interview. The indicator of whether implants were available on the day of the interview had a sensitivity of 100%, though just below the threshold for specificity (67%). The indicator for whether the facility experienced any stockouts of injectables in the previous 3 months was also 100% for sensitivity and 92% for

specificity. Sensitivity for stockouts of implants was just below the threshold (67%), but 92% for specificity.

The indicator for whether facility's have a private room for FP consultations demonstrated high sensitivity (94%) but low specificity (33%). The opposite was true for whether the facility had a space designated for youth activities, at 45% for sensitivity and 95% for specificity. Table 4.5 provides an overview of the reported and observed percentages, as well as the sensitivity and specificity, of the IS indicators for HSAs and CBDAs.

Table 4.5: Implementation strength indicators reported by HSAs and CBDAs versus observed by the interviewers with sensitivity and specificity of the HSA phone interview method (weighted)

Implementation Strength Indicator	Reported Percentage (n/N)	Observed Percentage (n/N)	Sensitivity (%)	Specificity (%)
Health Surveillance Agents (HSAs)				
Conducted mobile outreach in last year	71 (134/188)	47 (88/188)	83	39
Conducted youth events in last 3 months	56 (105/188)	13 (25/188)	80	48
Have family planning Guidelines	96 (181/188)	65 (123/188)	98	8
Have family planning job aids	79 (149/188)	70 (131/188)	89	44
Provide oral contraceptive pills (OCPs)	55 (104/188)	63 (118/188)	70	70
OCPs available on day of interview	87 (72/83)	80 (66/83)	92	35
Had a OCP stockout in last 3 months	28 (23/83)	19 (16/83)	69	82
Provide injectables	69 (129/188)	83 (156/188)	77	72
Injectables available on day of interview	93 (111/120)	89 (107/120)	98	54
Had an injectable stockout in last 3 months	23 (27/120)	19 (23/120)	74	90
Community-Based Distribution Agents (CBDAs)				
Conducted mobile outreach in last year	30 (33/109)	28 (30/109)	47	76

Conducted youth events in last 3 months	83 (91/109)	50 (55/109)	91	24
Have family planning Guidelines	99 (108/109)	85 (93/109)	99	0
Have family planning job aids	83 (90/109)	87 (95/109)	84	29
Provide oral contraceptive pills (OCPs)	71 (77/109)	81 (88/109)	82	76
OCPs available on day of interview	92 (66/72)	86 (62/72)	95	30
Had a OCP stockout in last 3 months	47 (34/72)	39 (28/72)	70	66

Mobile outreach showed high sensitivity (83%) and low specificity (39%) among HSAs, and the opposite pattern among CBDAs (47% and 76% respectively). The demand generation indicator of having recently conducted youth events demonstrated high sensitivity and low specificity among HSAs (80% and 48%) and CBDAs (91% and 24%). The indicators for FP supplies had high sensitivity but very low specificity for both HSAs and CBDAs. For instance, the sensitivity for FP guidelines was 98% among HSAs and 99% among CBDAs, while specificity for this indicator was 8% for HSAs and 0% for CBDAs.

The indicator for providing OCPs was above the threshold for sensitivity among HSAs (70%) and CBDAs (82%), and specificity among HSAs and CBDAs as well. The indicator for availability of OCPs on the day of interview demonstrated high sensitivity for both HSAs (92%) and CBDAs (95%), but low specificity (35% for HSAs and 30% for CBDAs). The indicator for OCP stockouts hovered around the threshold, with sensitivity at 69% for HSAs and 70% for CBDAs, and specificity at 82% for HSAs and 66% for CBDAs.

Sensitivity and specificity was above the threshold for HSAs providing injectables (77% and 72%), higher sensitivity (98%) and lower specificity (54%) for availability on day of interview,

and above the threshold for both sensitivity (74%) and specificity (90%) for the recent injectable stockout indicator.

Feasibility

We found that the cost per mobile interview was $10.56 (or 7,655 Kwacha), while the cost per in-person interview was $25.48 (9,070 Kwacha). One of the largest drivers of cost in the mobile interview phase stemmed from the airtime used. The biggest driver of cost in the in-person phase was transportation to the inspection sites. Management costs comprised a large chunk of the costs in both mobile phone and in-person interviews, but didn't differ substantially between them.

Discussion

The 2017 Malawi ISA Validation showed that nearly all health workers (no matter how remote) in several districts in a low income country like Malawi could be interviewed on the phone due to increasing saturation of mobile phones and improving networks. We met our targets for each health worker cadre, though when enumerating the CBDA population during IC interviews, we realized that there were far fewer CBDAs in these two districts than initially estimated. .

This study tested whether ISA data obtained from mobile phone interviews were valid when compared to the traditional data collection method of in-person interviews. We found that the majority of ISA indicators at the health facility, HSA, and CBDA levels in Malawi were above the 70% threshold for sensitivity. However, there were fewer indicators that met this threshold

level for specificity. There are three underlying reasons for this finding: (1) confusion with technical terms; (2) poor recordkeeping; (3) desirability bias.

During the qualitative questioning following the in-person inspection, many respondents admitted that they did not clearly understand what certain questions were asking about. For instance, respondents were often unsure of what the exact definition of youth events was, or what the difference between FP guidelines and job aids were. This confusion occurred more often at the HSA and CBDA levels, where training and education is often less. This is likely because these CHWs are less familiar with technical terms, such as YFHS, than the In-Charges at the health facility. We recommend that future studies conduct a pilot test or qualitative survey to understand what the confusing terms may be at the different HW levels in that context and revise the survey questions accordingly.

The second major issue leading to lower validity findings in this study was the lack of consistent, quality recordkeeping at all levels. The indicators for FP commodities had much higher sensitivity and specificity. This is largely because all ICs and HWs have an FP register that they have been trained to fill out and submit on a regular basis. When we conducted the in-person inspection, we quickly realized that these commodity indicators were the only ones that HWs consistently recorded. There were inconsistent records for supervision, demand generation activities, and mobile outreach. Even so, the IC kept more records of these indicators than the HSAs and CBDAs. Similar studies, such as Hazel et al, that demonstrated higher sensitivity and specificity largely because they evaluated a very specific program that had been recently implemented with clear components.[115] This study collected data on indicators that measured the

processes of multiple FP programs and thus, the gold standard for these indicators was often incomplete or inconsistent. This study employed a more conservative approach to sensitivity and specificity, whereby if the record was not found in person, the in-person record was marked as a "No." Future studies should carefully understand what records different levels of HWs keep and whether certain indicators can be validated. Moreover, this finding also demonstrates that quality and consistency of recordkeeping in Malawi for these indicators needs to be improved for better tracking and understanding of implementation.

The third major issue in this study is that there may be a desirability bias among respondents during phone interviews.[142,143] In other words, respondents may be more likely to give answers that they believe data collectors want to hear rather than giving truthful answers that they would ordinarily give if the data collector was in front of them. We theorized that this would not be the case do to the structural, not process, nature of the questions. Still, some may believe that the phone interview is in fact a performance review that would affect their job. Yet, as described earlier, we cannot confirm that in-person interviews would have been more accurate in our study because of the lack of consistent, quality recordkeeping by all three types of HWs. The only alternative that would likely be more accurate is if data collectors directly observed health workers to see if the ISA indicators were met. Needless to say, this would be tremendously time and resource intensive. Moreover, several studies have shown that using mobile phones interviews for data collection provided accurate results at cheaper costs.[135,136] Further research should be conducted to explore the effect of desirability bias for this type of study which measures structural quality and implementation strength.

There are a number of improvements that could be made for future studies to deal with this issue. First, data collectors could make it abundantly clear before the interview starts that the interview is not a performance review; that the interviewers want honest feedback so that improvements can be made to the health system and this will in no way affect their jobs. Second, studies can make sure that data collectors do not start the interview until the respondents confirm that they are in front of their records. This way, at least there can be more confidence that HWs are actually consulting their records rather than responding by memory. This likely is difficult for the remote CHWs because of their lack of network coverage in the areas they provide, which is consistent with the literature.[135,136,144] The qualitative interviews showed that many of the most remote CHWs had to go to a different area from where they provide to get cell service, and thus could not consult their records. Third, future studies can inform respondents that 10% of interviews will be randomly verified in person. This could help make respondents answer from their records rather than from memory if they believe their answers will be checked. Of course, there were also certain indicators, such as for FP guidelines, where specificity was so low because so few respondents answered no. Thus, if the 2 out of the 4 respondents that answered no to this question, specificity would be skewed very low.

Collecting ISA data via in-person interviews was found to be over double the cost per interview versus collecting the same data using mobile phone interviews. One major advantage of the mobile phone interview method is that it because it can be conducted from a central location, it saves on transportation costs and supervision is easier and more consistent. A sizeable portion of the cost associated with the mobile interview method stem from purchasing equipment such as the mobile phones, sim cards, and headsets. However, these are a one-time purchase so any

future data collection exercises using this technique will not have this cost and be even more cost-efficient. Note that the costs analyzed and reported are specific to the Malawi context, though we do not anticipate significant differences in the cost comparison between mobile phone and in-person interviews in other contexts. In fact, Malawi is a relatively small, dense country and we therefore would expect transport costs to increase in other, larger contexts. This study provides an example of how a low-income country in sub-Saharan Africa with significant resource constraints has the capacity, network, and mobile phone saturation (specifically among health workers) to conduct ISA interviews using this method. The significant cost savings from the mobile phone method adds to the debate about the tradeoff between validity and feasibility for conducting ISA interviews. This study suggests that it is much more cost-effective to use the mobile phone method for the indicators that demonstrated validity above the 70% threshold.

Limitations

The first limitation is that the districts of Dowa and Ntcheu were purposively chosen for their proximity to Zomba, where mobile phone interviews were conducted. IS data collected in these two districts may not be representative of every district in the country, especially the remote ones. Still, the objective of this study is to assess feasibility of the method of collecting IS data and the validity of the data, not to have data that is generalizable to the whole country.

Another potential limitation of this study is that interview teams needed to obtain contact information for the health workers from In-Charges prior to actually conducting the interviews. These In-Charges could inform the providers that the interview team will be calling them and this could affect their responses. Similarly, we informed the health workers during the consent

process prior to the interview that an inspection visit will occur at their health facility or village clinic to check their responses after a few days. Some health workers could have made changes to their records or supply stocks to make it appear that they have reported accurately. On the other hand, while other studies have shown that response rates are lower for mobile phone data collection versus in-person, our study did not have an issue with this.[145] This is likely due to a number of reasons, including the IC informing its HWs of our call, the short and simple nature of our survey, and that we interviewed health workers who are more likely to have a phone than a random member of the population.

As mentioned earlier, there also could be issues around recall bias and desirability bias among health providers who are being asked about their FP readiness and practices. Other studies have looked deeper into the demographic differences between respondents who had more valid responses than others.[120,146] This could be a potential area for further research, especially for surveys involving health workers. On the other end, there could be interviewer bias, where some interviewers ask or clarify survey questions more clearly. While the supervisors of each team were trained to closely monitor this, the relative simplicity of this quantitative survey also argues against such bias having a substantial effect.

Another limitation is that we used the records and observations of health workers as a gold standard to test for sensitivity and specificity. These records themselves are prone to error. As seen during data collection, these records were not complete across every health facility and village clinic in these two districts. However, this is the best choice available for validating the mobile phone interview method. Future studies could also explore other data collection methods

such as computer-assisted telephone interviews (CATI), interactive-voice response (IVR), and short message service (SMS). We were also not able to validate all the ISA indicators using this method as a gold standard. For instance, ICs and health workers did not consistently keep training records. We tried to obtain training records from the district and national authorities, but these records were not consistently available across the country.

Repeatability of the mobile phone interview method was not assessed for this study, which is a limitation. However, in order to do this, a health worker who has already been interviewed would need to be interviewed again using the same method. This can be problematic as bias is introduced because the respondent is not experiencing it for the first time. The responses we seek from health workers are highly objective (e.g. have you been trained in YFHS?) and not ones we can expect must variation upon repeated measurement. Previous studies show that repeated measurements are rarely made in method comparison studies.[147]

Conclusions

The rapid increase in mobile phone ownership and phone network availability in lower income countries offers a new, innovative avenue for researchers to collect more data with less resources and capacity. Yet, there is a dearth of rigorous research that test the validity of remote data collection in lower income countries, especially among health workers.[120,148] This study tests whether using phone interviews can produce valid IS data and the difference in feasibility between the mobile phone and in-person interview methods. While there are clearly issues with using mobile phone interviews, we believe that many of these can be addressed through relatively simple adjustments. We highly recommend that pilot testing or qualitative surveying is

conducted to increase understanding of questions among all HW types and ensure respondents are using their records, not their memories, to provide answers. In addition, we found that data elicited from mobile phone interviews could be more valid when assessing a single program and its specific, measurable components. The finding about poor records in Malawi point to future research that can be conducted assessing quality of routine data collected. Once these adjustments are made, mobile phone interviews can give practitioners a more efficient, consistent, and inexpensive way of collecting primary data for the ISA. This would allow for more immediate reports and dissemination materials that can inform data-driven decision-making, as well as repeated application of the tool to check implementation progress.

Chapter 5: Comparing quantitative methods that construct multi-level composite implementation strength scores of family planning programs in Malawi

Background

Global estimates of total fertility rates have been reducing, in large part due to the increasing proportion of women of reproductive age using modern contraceptives.[4,132] However, the slowest declines have been observed sub-Saharan Africa.[149] In order to improve trends in family planning (FP), many national governments in this region have been trying to implement programs to increase the use of modern contraceptives.[133,134,150] Yet, there has been limited ways to capture how strongly large-scale, multi-pronged FP programs are being implemented in these low and middle-income countries in one summary measure.

Implementation strength assessments (ISA) aim to the measure the strength or intensity with which packages of interventions are delivered as they are rolled out, and can test how strength may be associated with public health outcomes.[40,42,44] ISAs measure the amount of a program that is delivered, instead of how much of a program is received (coverage).[64,151,152] They can provide strong evidence of program effectiveness, especially alongside a comprehensive evaluation that measures quality, program utilization, and coverage. Information gleaned from an ISA can afford program managers and implementers specific information about what is and isn't working in their program so they can make real-time changes and improvements.

In 2017, the National Evaluation Program (NEP) and the National Statistics Office (NSO) of Malawi conducted an implementation strength assessment (ISA) that aimed to understand how a variety of supply-side FP programs in Malawi were being implemented.[153] This type of evaluation, where the output of multiple programs rather than a single one are being evaluated, has precedence in implementation research literature.[47,48]

The conceptual framework of the ISA is a natural extension of prior frameworks that measure quality of care (QoC); starting with the Donabedian framework and its three main dimensions of structure, process, and outcomes, to the Bruce-Jain framework which funnels QoC into six elements of family planning programs.[74,154,155] The major domains of the ISA stem from the structural dimensions of the Donabedian framework, which describe the quantity of program delivered. The ISA domains are training, supervision, FP method choice and availability, demand generation activities, and accessibility. Similar ISAs have been conducted on child health.[138,152,156]

While detailed results are useful for implementers to improve programs, national and subnational planners need to be able to assess, compare, and act upon the strength of programs as a whole, across multiple domains and indicators. They need to determine whether strength (ideally combined with other information from the impact chain, as above) relates to impact. In order to facilitate better interpretation and decision-making based on the evidence the ISA produces, developing a single summary score or index from these dimensions can be valuable.[157,158,159,160]

The 2017 ISA collected data from government, Christian Health Association of Malawi (CHAM), and NGO hospitals and health centers. Due to health system constraints, CHAM and NGO facilities play a major in extending health services in areas with little public options in Malawi.[52] We assessed IS not only at facilities, but also of community health workers because FP programs are implemented at both of these levels. Extending FP services via CHWs is critical in contexts like Malawi, especially because the injectable is the most popular method and certain CHWs can provide this to where women live.[55] In Malawi, there are four types of health workers that deliver FP across Malawi: health facility in-charges (ICs), health facility workers (HFWs), Health Surveillance Assistants (HSAs), and Community-based Distribution Agents (CBDAs). Thus, it would be valuable to understand the strength of implementing not just at the facility level, but across a facility's catchment area which includes this extension workers that play a key role in service provision. The literature supports this, as it has shown that CHWs are an essential source for FP methods and demand generation, especially in low-income settings.[60,99,161]

Previous studies that summarize QoC data, often from Service Provision Assessments (SPA), have used four index methods: simple additive, weighted additive, principal components analysis (PCA), and exploratory factor analysis (EFA).[162,163,164,165,166] These studies combine information at either the health facility or the community health worker (CHW) levels; but none that we have seen have combined community and facility worker strength in a score for the whole catchment area.

Drawing from studies in other fields, we found that multiple levels of data are often combined by either aggregating lower level data up to the higher level or by using a Bayesian mixed effects model (MEM) to individually contribute data from all levels to a multi-level score. The MEM can use prior information about similar health facilities and workers to produce a posterior distribution of improved IS scores and also can account for clustering at multiple levels.[167,168]

Using the 2017 Malawi ISA data, this paper will explore four index methods that combine data across IS domains and indicators, as well as two methods that combine across health worker and health facility data to construct IS scores for each health facility's catchment area. This paper will also compare how well each method captures variation in the data and assign implementation strength scores at different levels.

The ultimate goal of this research is to show which method(s) of creating scores we believe is/are best and how we came to those decisions, and provide evaluators and researchers with a guide of how to create an IS score for a catchment area. Being able to capture this catchment area score will allow decision-makers to quickly understand and compare how strongly their programs are

being implemented on the ground. In turn, this can lead to more informed choices on how to optimize their program delivery to ultimately increase modern contraceptive use among their population.

Methods

Data collection

Chipokosa et al provides an overview of the 2017 Malawi ISA, including the sampled population at the facility and health worker levels, as well as background characteristics and findings for each IS indicator.[153] Briefly, the ISA measured the quantity of FP programs delivered in Malawi across the five IS domains described in Table 5.1 below. This data is collected at the health facility level, from all ICs and HFWs, and at the CHW level, from all HSAs and CBDAs across Malawi. Data collectors conducted phone interviews with ICs, HFWs, HSAs, and CBDAs across Malawi. The Johns Hopkins School of Public Health Institutional Review Board and the Malawi National Health Science Research Committee approved this study in April 2017. All interviews were conducted from a call center in Zomba from April to August 2017.

Selection of Indicators

The first step in creating an IS score is to transform the raw data collected to IS indicators. Table 5.1 below lists each indicator per domain and worker type. Questionnaires for each data collection tool can be found in Annex C. Note that the mobile phone interviews were conducted separately for each HW type (IC, HFW, HSA, or CBDA) and not every indicator is relevant to each type. The questions were standardized across data collection tools to allow for comparisons across HW types. All indicators were coded as either 1 (if yes) or 0 (if no).

Table 5.1: Indicators per implementation strength domain and health worker type

IS Domain	Indicator	HW Type
Training	Appropriately trained in FP*	HFW, HSA, CBDA
	Ever trained in YFHS	HFW, HSA, CBDA
Supervision	Supervised for FP in last 3 months	HFW, HSA, CBDA
	Last supervision covered youth FP topics	HSA, CBDA
	HF has received supervision that included FP from someone external to the facility in previous 3 reporting months	IC
	HFs whose supervision checklist of HWs includes Youth FP	IC
Contraceptive Methods and Supplies	Provides range of FP methods appropriate to type**	IC, HSA, CBDA
	Appropriate FP method available on day of interview**	IC, HSA, CBDA
	Has FP guidelines and job aids	IC, HSA, CBDA
	Has youth FP guidelines	IC, HSA, CBDA
	HF provides FP methods branded with social marketing	IC
	HF has FP pamphlets	IC
Demand Generation Activities	Conducted youth event in last 3 months	IC, HSA, CBDA
	Conducted SRH talks in last 3 months	HSA, CBDA
	Conducted youth spaces in last 3 months	IC, HSA, CBDA
	Conducted community meetings in last 3 months	IC, HSA, CBDA
	HF has peer educators for FP	IC
Accessibility	Ensures privacy during FP consultations	IC, HSA, CBDA
	Provides FP at least more than 12 hours per week	HSA, CBDA
	Provides FP at least more than 24 hours per week	IC
	HF has private room for FP consultations	IC
	HF has space designated for youth consultations & activities	IC
	HF has conducted mobile outreach since Jan 2017	IC

*Pertains to whether the HW is appropriately trained out of the choices of counseling, condoms, OCPs, injectables, and implants. HFWs should be trained in all, HSAs on all except implants, and CBDAs on all except injectables and implants

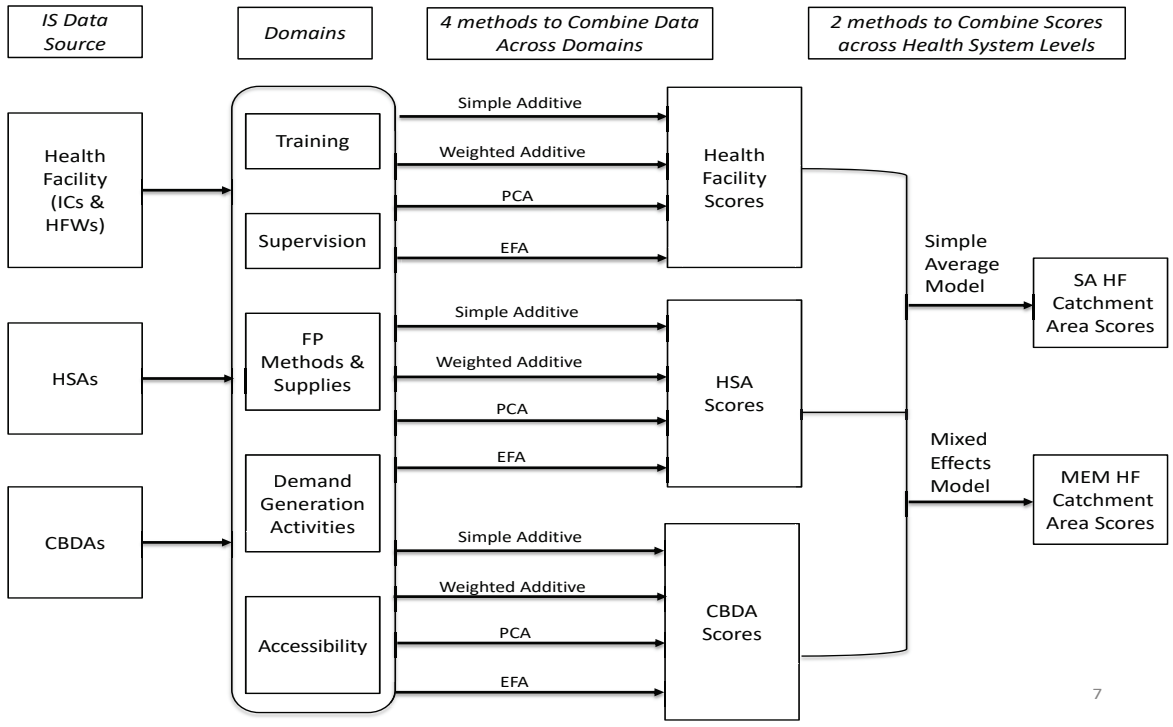
**Same as appropriate training. Provision and availability of method type is based on HW type.

We created a composite measure for FP training and for method provision and availability (as seen by indicators with asterisks in the table) to allow for combining data across HW types. We recognize that HW types are allowed to provide different types of FP methods (i.e. CBDAs only

provide male condoms and OCPs, while HSAs provide male condoms, OCPs, and injectables). Thus, the "appropriately trained in FP" indicator is only coded 1 if that HW type received training in all of the methods that they are supposed to provide. In other words, a CBDA received a 1 if it was trained in FP counseling, condoms, and OCPs, while an HSA received a 1 if it was trained in the all of these methods plus injectables. The same process was used for "appropriate" method provision and availability.

After transforming the raw data into indicators, we then tested different methods to (i) combine indicators within and then across domains (4 methods); and (ii) combine data across health facility (IC and HFW) and community health worker (HSA and CBDA) levels (2 methods) to create a catchment area-level IS summary score for each health facility in Malawi. Figure 5.1 describes this process of constructing IS scores at the catchment area level.

Figure 5.1: Flowchart describing process of constructing implementation strength summary measures that combines data across domains and health system levels



Combining indicators within and across domains (4 methods)

As described in the background, we identified four commonly used index methods to combine the indicators across domains: a simple additive index, a weighted additive index, a PCA index, and an EFA index.[156,157,159,163,170]

Simple Additive Index (SA)

This method is simply the sum of all IS indicators, if each indicator equals one. The first step is to use a priori hypotheses to narrow to the key sentinel indicators. This is done for the simple and weighted additive index because each indicator can contribute more than in the factor analyses indices. After this, each indicator is added to obtain a total score and this is divided by the total number of indicators.

$$Y_{\text{additive standardized}} = ((\sum_{i=1}^{n} x_i) \ /\text{n})$$

Where x is the indicator and n is the total number of indicators.

Weighted Additive Index (WA)

This method is similar to the previous one as it employs an additive method to the same indicators but it also takes the number of indicators per domain into account. Thus, each indicator within a domain is added together and then divided by the sum of indicators in that domain. These domain scores are added together and then divided by the total number of domains, creating the total weighted additive score.

$$Y_{\text{weighted additive}} = \sum_{d=1}^{m}(\sum_{i=1}^{n} x_{di}/n_d) \ /\text{n}) \ /\text{m}$$

Where d refers to domains and m is the total number of domains.

Principal Component Analysis (PCA)

PCA reduces the number of highly correlated observed variables to a smaller number of uncorrelated, linear combinations of weighted observed variables (i.e. principal components) that account for the maximal amount of variation in the data. For instance, two highly correlated variables on a scatterplot would look like an ellipse tilted at 45 degrees. Rather than using these original axes, this method allows one to rotate the data so that the first principle component is the main diagonal of the ellipse (at 45 degrees) and the second is perpendicular to the first.

These components serve as analogues to the domains in the additive models above. The PCA uses all the IS indicators rather than being more parsimonious of choosing indicators as in the additive indices. We determined the number of components to use via parallel analysis, which is the most common method for doing this.[169] We then selected the indicators with loadings above 0.3 per convention and used them as weights for each indicator.[170]

$$Y_j = \sum_{c=1}^{m}\left(\sum_{i=1}^{n} a_{ci}x_{ci}/n_c\right)/\mathrm{n}\right)/\mathrm{m}$$

Where i is the number of indicators; a represents the factor loadings of each indicator for each jth health worker or facility; c is components; m is total number of components; y is equal to the predicted score from the chosen components for each jth health worker or facility

Exploratory Factor Analysis (EFA)

EFA is a variable reduction technique similar to a PCA, but it hypothesizes an underlying factor structure and latent relations among the set of IS variables. In this way, it estimates factors which influence responses on the observed variables, as opposed to the PCA which simply minimizes the sum of the squared perpendicular distance to the component axis. These factors

account for only the common variance in the data and the diagonals have already been adjusted for the unique factors, as opposed to the components in the PCA who retain the maximal amount of total variance of the observed variables.[170]

These factors serve as analogues to the components in the PCA and the domains in the additive models. With the PCA and EFA, the components and factors emerge from the statistical analysis rather than the domains having been constructed a priori in the additive indices. As with the PCA, the full set of indicators is included in the analysis, a parallel analysis determines the number of factors to use, and the factor loadings above 0.3 are kept and used as indicator weights. The equation is the same as the PCA, with the new factor loadings replacing the component weights. Cronbach's alpha for internal consistency was calculated for the individual index items.

Each of these four methods combines data across indicators separately at the health facility and CHW levels, resulting in two sets of scores for each method. The next sub-section describes how these scores are then combined across the facility and CHW levels; the last phase depicted in Figure 5.1.

Combining data across health system levels (2 methods)

We explored one simple and one more complex method of combining data at the health facility and health worker levels. These two combining methods were employed for each of the four index methods described in the section above. Thus, there will be a total of 8 different indices that will be compared: 4 indices (SA, WA, PCA, EFA) where facility and worker data are

combined using the simple average method, and 4 indices (SA, WA, PCA, EFA) where we use the mixed effect model.

Simple average model

Table 5.2 below lists the number of indicators and data sources used at each level (facility or CHW) for each index type (SA, WA, PCA, or EFA). First, an IS score is calculated at the HSA/CBDA level using these four index methods. Then, an IS score is similarly calculated at the health facility level by combining indicators from the IC and HFW surveys. If a health facility has multiple HSAs or CBDAs, the HSA and CBDA scores are separately averaged up to the facility level and added to the facility score as two extra (HSA average + CBDA average) domains in this model. This results in a catchment area score for each health facility.

Table 5.2: Indicators and data sources used to calculate CHW, health facility, and catchment area level IS scores using the simple average combination model

Level	SA & WA Index	PCA Index	EFA Index
HSAs & CBDAs	11 indicators across 5 IS domains Only from HW survey	18 indicators included across 7 components Only indicators with loadings more than 0.2 were included in score	12 indicators included across 7 factors Only indicators with loadings more than 0.2 were included in score
Health Facilities (IC + HFWs)	14 indicators across 5 IS domains 10 from IC survey; 4 from HFW survey, aggregated to HF level	23 indicators included (with loadings more than 0.2) across 4 components	18 indicators included (with loadings more than 0.2) across 4 factors
Health Facility Catchment Area (HF + HSAs + CBDAs)	16 indicators across 7 domains HF indicators + 2 extra domains for HSA & CBDA scores HSA and CBDA results aggregated to HF level	22 indicators included (with loadings more than 0.2) across 5 components Added aggregated HSA and CBDA scores to the HF indicators and then plugged into PCA	19 indicators included (with loadings more than 0.2) across 5 factors Added aggregated HSA and CBDA scores to the HF indicators and then plugged into FA

In the simple and weighted additive column, 2 domain scores (one for HSAs and one for CBDAs) are added to 14 indicators across 5 domains from the facility level. In the SA, these scores are treated simply as indicators and added to the other 14. In the WA, these scores are treated as domains and added to the other 5 domain scores.

The same process is used for the PCA and EFA indices, moving from CHW to facility to catchment area scores. In these indices, a wider set of indicators is plugged into the PCA or EFA and only those with a factor loading of more than 0.3 are included in score creation. The aggregated HSA/CBDA indicators with factor loadings above the threshold are included in the PCA or EFA.

Bayesian mixed effects model

The second method combines health facility and CHW scores using a Bayesian mixed effect model (MEM). The dataset that the MEM uses has the scores (calculated from the four methods above) for each individual health worker and health facility. The model is then employed to produce a posterior distribution of IS scores at the catchment area level. The major benefit of this approach is that it borrows information from similar health facilities and workers to construct a more stable representation of IS across a facility's catchment area.

The random effects (or clusters) explored for this model were the districts, facilities, and individual health workers, as these were the three nested supply-side levels of the dataset. The fixed effects explored after a literature review and with the data available were health facility type (hospital or health center), managing authority of the facility (MoH, CHAM, NGO), region

(North, Central, South), and a dummy variable called "level" that designates whether the data is for an individual health worker or health facility.[171] The outcome was the IS score at the catchment area level from one of the four index options. The basic regression model is shown below:

$$\mathrm{Y} = \underbrace{X\beta}_{fixed} + \underbrace{Zu}_{random} + \varepsilon$$

where

y is the n-by-1 outcome vector, and n is the number of observations.

X is an n-by-p fixed-effects design matrix (predictors)

β is a p-by-1 fixed-effects vector (regression coefficients).

Z is an n-by-q random-effects design matrix (random complement to the fixed x)

u is a q-by-1 random-effects vector (random complement to the fixed β)

ε is the n-by-1 residuals vector (part of y not explained by model)

Different model specifications (for fixed and random effects) were analyzed and comparisons made on attributes such as a priori hypothesis, as well as model fit and the percentage of variance explained. The model that explained the most variation and had the highest model fit criteria from Akaike Information Criteria (AIC) and log likelihood was then chosen; lower AIC and higher log likelihood indicates higher goodness-of-fit.[172,173] Beta coefficients for the fixed effects in these models were not analyzed because we did not use them to compare models. The resulting eight score distributions were also compared using two-way scatterplots and box plots. To measure the relatedness of clustered data, we compare the intra-cluster coefficient (ICC) of each of the score distributions resulting from all of the combination methods. The ICC is a ratio of the between-cluster variance to the total variance.[174]

Using the findings from the previous steps, we chose the strongest method that combines data across IS indicators and domains and then compared the score distributions that result from using the simple average and mixed effect models. We used two-way scatterplots, box plots, and funneling plots to compare the score distributions.

Another way we chose to compare the combination methods is to analyze how each index method predicts the common FP output indicator: couple-years protection (CYP). CYP estimates the amount of protection provided by FP services over the course of a one-year period based on the volume and type of modern contraceptives provided. CYP is calculated by multiplying the quantity of each modern method by a conversion factor. Each contraceptive method type has a different conversion factor (e.g. condoms are 120 units per CYP; injectables are 4 doses per CYP). This yields an estimate of the duration of protection provided by one unit of that contraceptive method; the CYPs for each method are then summed to obtain a total CYP.[175,176] CYP was calculated using utilization data collected in the 2017 Malawi ISA from health facilities and CHWs.

We divided the catchment area IS score distributions for each method into quintiles and analyzed how CYP changed as catchment areas scores in each IS quintile increased. Due to the fact that we are measuring IS at the catchment area level, we decided to adjust CYP by the population of each catchment area. Otherwise, catchment areas with larger populations could have larger CYPs that could skew the relationship between IS and CYP at the catchment area level. The data source for these catchment area population is the 2008 Malawi population census report.[177]

Using these steps, we aimed to construct and compare different types of implementation strength scores that measure the aggregate effect of FP programs delivered across every health facility's catchment area. All the analyses reviewed above were conducted using R version 3.4.1 software.[178]

Results

Overview of ISA findings

Table 5.3 shows that of the 666 facilities in Malawi, the 2017 Malawi ISA interviewed 660 facilities. Of these facilities interviewed, 58 did not provide FP; 95% (55) of these were Christian Health Association of Malawi (CHAM) facilities, in accordance with their policies. However, 93% (51) of these CHAM facility ICs who informed data collectors that they do not provide FP, stated that they had HSAs and CBDAs that provide FP in their catchment area.

Table 5.3: Sampled population for ISA in Malawi, by HW type

	ICs	HFWs	HSAs	CBDAs
Study Population	666	1968	4131*	3430
Interviewed	660 (99%)	1815 (92%)	4048 (98%)	3208 (94%)
Provide FP	602 (91%)	1777 (98%)	3885 (96%)	3121 (97%)
Consent given	602 (100%)	1773 (99%)	3883 (99%)	3121 (100%)

*target was to sample 85% of HSAs due to large study population; so 99% of sampled

Chipokosa et al showed that nearly one quarter (22%) of total facilities interviewed were CHAM facilities.[153] NGOs such as Banja la Mtsofolo (BLM) and Family Planning Association of Malawi (FPAM) comprise about 7% of the facilities interviewed. Over 80% of all facilities interviewed were health centers, not hospitals. Most health workers, regardless of type, were in

their mid-thirties, identified as Christian, and married. Key differences between health worker types include that HSAs were likely to be male (67%) while health facility workers (HFWs), such as doctors and nurses at facilities, tend to be more female (68%). Another difference is that HFWs and HSAs have been working in their catchment areas much longer than CBDAs.

This study also showed that CHAM facilities perform worse than MoH or NGO facilities across many IS indicators. A much lower proportion of CHAM facilities provide (42%) and have FP methods (33%) and guidelines available (54%), conduct demand generation activities (<30%), and conduct mobile outreach (37%) or have a private room for FP consultations (55%). All HW types are similar on being trained in FP, being recently supervised in FP, having FP guidelines and job aids, and providing branded methods. A lower proportion of HSAs provide (49%) and have all their FP methods on the day of interview (29%), as well as having been trained in YFHS (26%). CBDAs have higher proportions of conducting demand generation activities (>66%).

While Chipokosa et al provides an overview of the individual indicators from the ISA, the next step that this paper takes is constructing summary measure in order to understand the aggregate quantity of FP programs delivered in Malawi.

Combining data across IS indicators and domains (4 methods)

Four methods were used to combine data across IS indicators per HW type, resulting in four sets of summary scores per HW type. Table 5.4 shows the median IS score and inter-quartile range (IQR) for each HW type and combination method. The median IS scores for ICs range from

0.52 to 0.58 across all four combination methods, while HFWs range from 0.40 to 0.50. At the CHW level, IS scores for HSAs ranged from 0.45 to 0.49, while from 0.60 to 0.64 for CBDAs.

Table 5.4: Median and interquartile range of IS scores for each HW type across four methods to combine data across indicators

	Simple Additive		Weighted Additive		PCA		EFA	
HW type	Median	IQR	Median	IQR	Median	IQR	Median	IQR
IC	0.52	0.38-0.68	0.52	0.38-0.67	0.56	0.41-0.68	0.58	0.42-0.70
HFW	0.45	0.27-0.55	0.40	0.27-0.53	0.50	0.36-0.65	0.40	0.25-0.52
HSA	0.45	0.36-0.63	0.47	0.30-0.63	0.46	0.32-0.58	0.49	0.35-066
CBDA	0.64	0.45-0.73	0.60	0.43-0.73	0.61	0.47-0.73	0.64	0.49-0.76

In order to better understand how the PCA scores listed in Table 5.4 above were constructed, Table 5 below shares the factor loadings of the PCA conducted at the health facility level. Four components were retained at the facility level after a parallel analysis was conducted.

Table 5.5: Factor loadings above threshold for principal components analysis of IS indicators at the health facility level

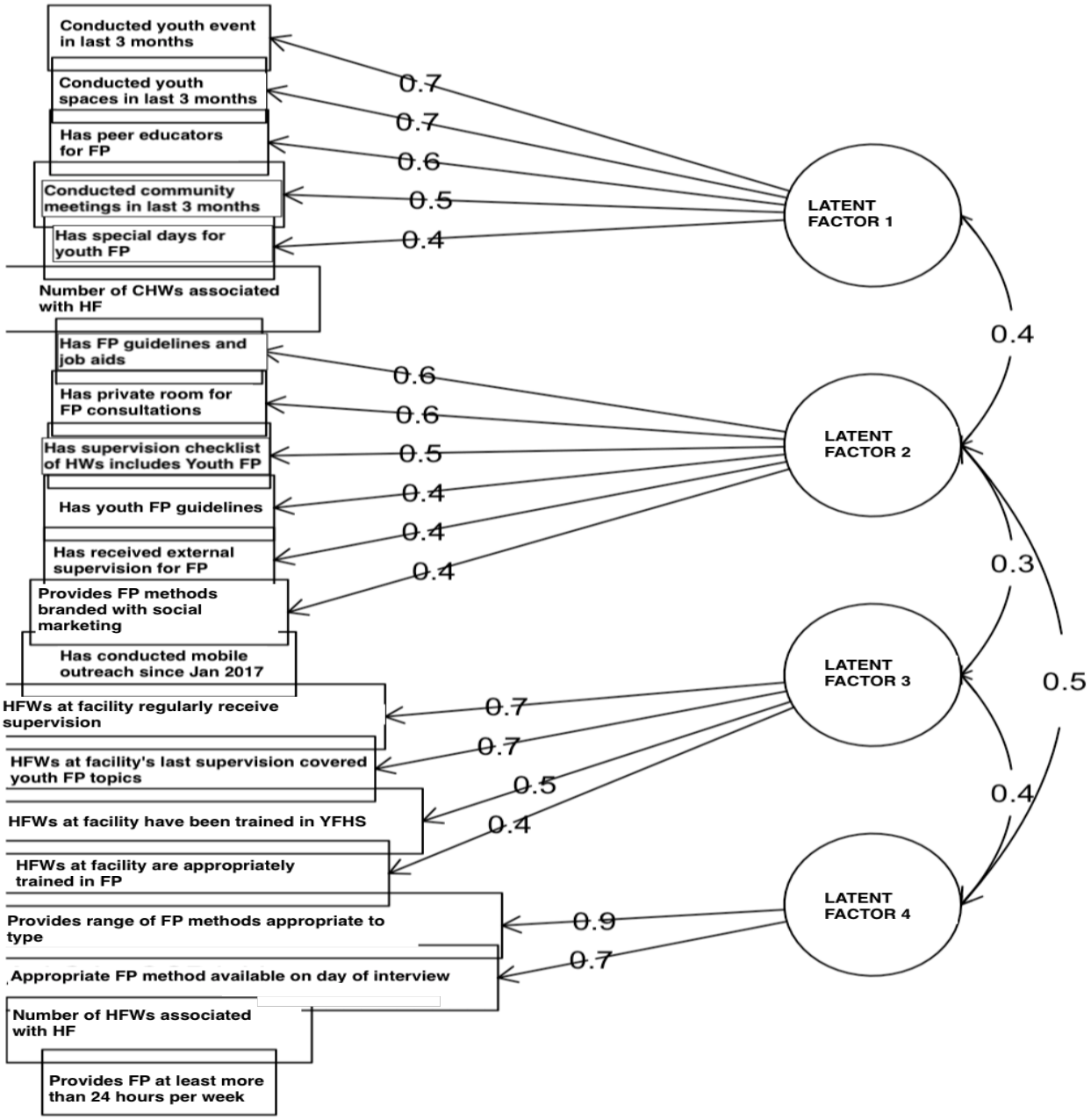
Items included in PCA with factor loadings > 0.3	PC 1	PC 2	PC 3	PC 4
Number of HFWs associated with HF				0.59
Number of CHWs associated with HF				0.72
HF has supervision checklist of HWs includes Youth FP	0.42	0.43		
Has received supervision that included FP from someone external to the facility in previous 3 reporting months	0.54			
Has youth FP guidelines	0.50	0.35		
Has FP guidelines and job aids	0.71			
Provides range of FP methods appropriate to type	0.55		0.35	0.39
Appropriate FP method available on day of interview	0.46			0.45
Provides FP at least more than 24 hours per week				0.33
Has special days for youth FP		0.51		
Has conducted mobile outreach since Jan 2017	0.44			

Has private room for FP consultations	0.70			
Conducted youth event in last 3 months		0.73		
Conducted community meetings in last 3 months		0.63		
Conducted youth spaces in last 3 months		0.73		
Has peer educators for FP		0.69		
Provides FP methods branded with social marketing	0.48			
HFWs at facility are appropriately trained in FP			0.56	
HFWs at facility have been trained in YFHS			0.66	
HFWs at facility regularly receive supervision			0.76	
HFWs at facility's last supervision covered youth FP topics			0.75	
	PC 1	PC 2	PC 3	PC 4
Eigenvalue	2.94	2.71	2.48	1.47
Proportion of Variance Explained	0.14	0.13	0.12	0.07
Cumulative Variance Explained	0.14	0.27	0.39	0.46

The indicators with factor loadings above 0.3 were retained and listed in Table 5.5 above. These factor loadings serve as weights to the indicators in the construction of facility-level scores. In this table, the first component groups more FP supervision and provision indicators while the second groups more demand generation indicators. The third component groups the HFW indicators, while the fourth groups accessibility and provision ones. This table serves as an example of what was done for each HW type when using the PCA combination method. Corresponding tables for the other HW types and for the final catchment area step can be reviewed in the Annex.

Figure 5.2 below provides an example of what was done for the EFA combination method. This figure depicts an EFA at the health facility level. It represents the underlying latent factors that explain variation in the data and how they link to individual IS indicators. Only indicators with factor loadings above 0.3 were retained and depicted in this diagram.

Figure 5.2: Diagram of latent factors and indicators with factor loadings at the facility level



The first latent factor for health facilities groups the demand generation indicators, while the second latent factor groups the supervision and FP supplies indicators. The third latent factor groups the HFW indicators for training and supervision, while the final latent factor groups the accessibility and provision indicators. The FA diagrams for the other HW types and the catchment area step can be found in the annex.

Combining health facility and CHW IS scores (2 methods)

After four sets of scores for each health system level were created, these scores were then combined to create a health facility catchment area level score using either a simple average or mixed effects method.

Simple Average Combination Method

Figure 5.3 shows a comparison of the four sets of scores (SA, WA, PCA, EFA) that use the simple average method to combine across health system levels. The mean and interquartile range are similar across all four methods, with means near 0.50.

Figure 5.3: Boxplots comparing IS scores using simple average heath system combination method across four indicator combination methods

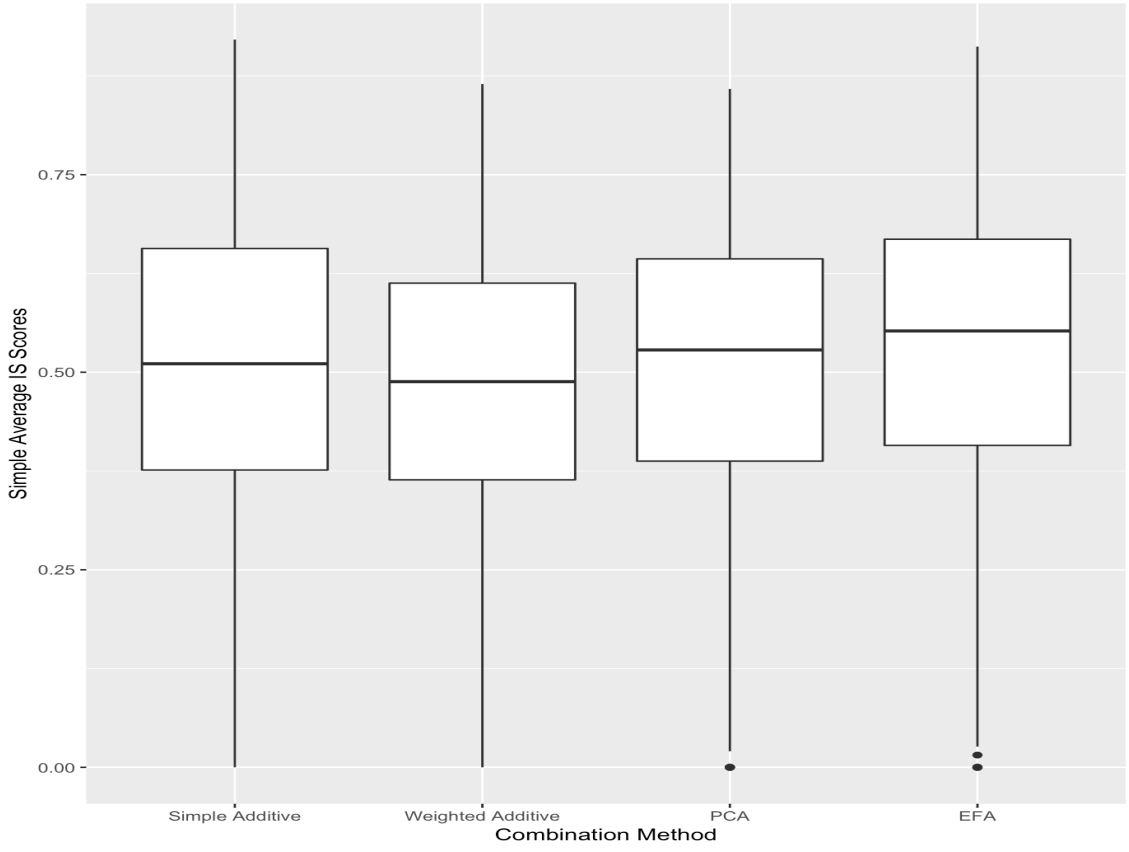
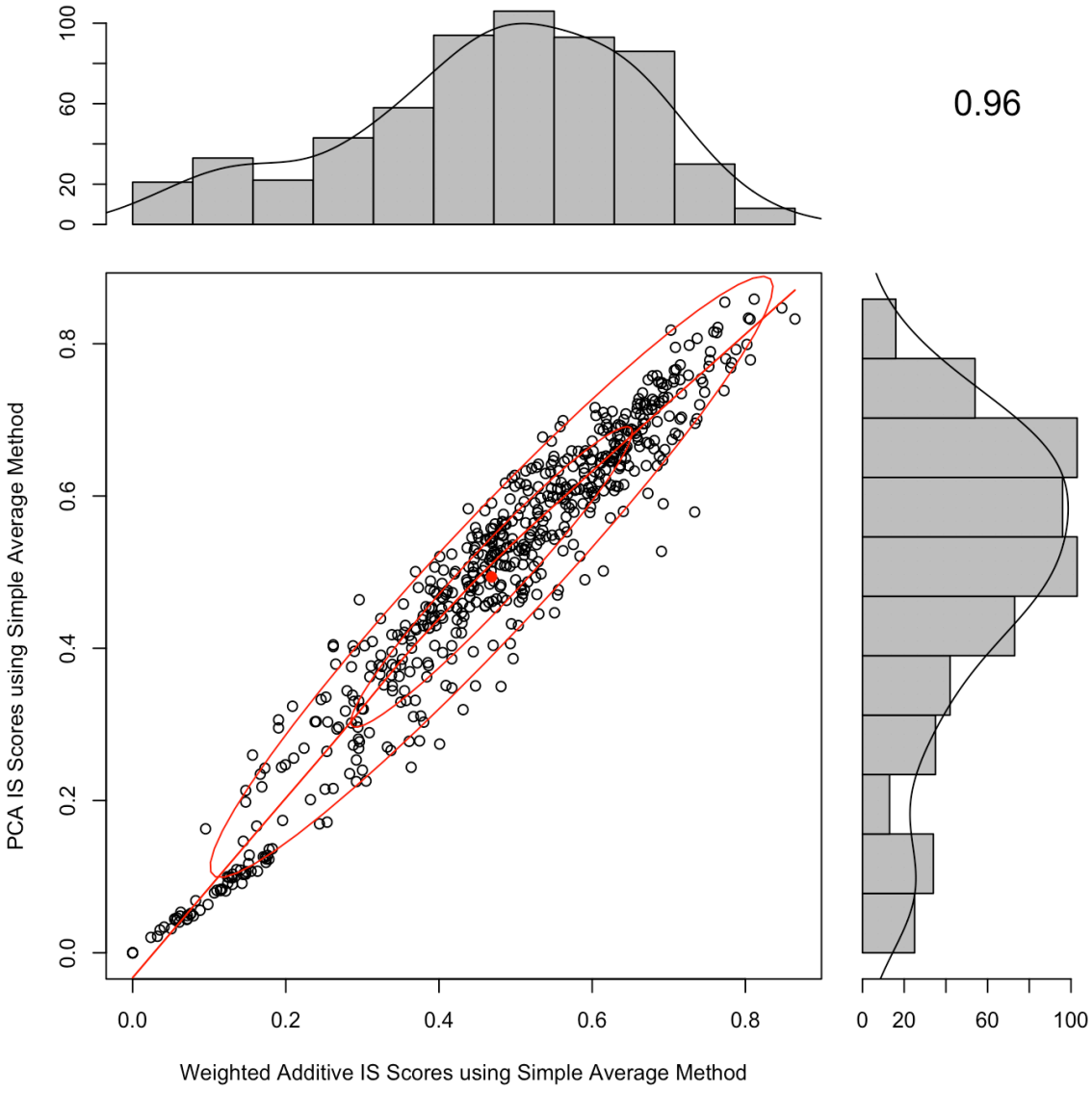


Figure 5.4 below shows a pairwise comparisons of the distribution of the weighted additive and PCA index methods using the simple average model via two-way scatterplots. The correlation coefficient is 0.96, showing that the two distributions are very similar.

Figure 5.4: Two-way scatterplot comparing the weighted additive and PCA IS scores that use the simple average combination model



We created similar two-way scatterplots comparing all of the score distributions and found that all six of the comparisons resulted in a high correlation coefficient of at least above 0.93. These

can be found in the Annex. This suggests that all four indices using the simple average combination model measured IS at the facility catchment area similarly.

Mixed Effects Combination Method

The mixed effects combination model separately inserts IS scores from each of the four indicator combination methods (SA, WA, PCA, EFA) as a fixed effect and then model fit was compared across various stepwise regression models that add the facility type, managing authority of the facility, and a dummy variable named level. Level represents whether the score is for a health facility or individual CHW; thus allowing for each CHW associated with a health facility to individually contribute to the IS score for that facility's catchment area. Model fit is measured by analyzing maximum likelihood estimation, specifically looking at AIC and the log likelihood for the regression models using each index method.

Table 5.6 below compares mixed effects models with different combinations of fixed and random effects. It only includes the weighted additive and PCA IS scores for ease of understanding and because the models that used simple additive or exploratory factor analysis scores had the lowest model fit out of the four methods.

Table 5.6: Comparing weighted additive and PCA mixed effects models

No	Model	Model Fit		Random Effects			
		AIC	Log Likelihood	District SD*	Facility SD	Indiv. SD	Residual SD
1	WA ~ facility type + level	-1634	824	0.05	0.03	0.06	0.21
2	WA ~ managing authority + level	-1648	833	0.06	$5*10^{-5}$	0.07	0.21
3	WA ~ facility type + level + district	-1500	784	n/a	0.03	0.06	0.21

4	WA ~ facility type + level + region	-1622	820	0.05	0.03	0.06	0.21
5	WA ~ managing authority + level + region	-1641	832	0.05	$6*10^{-5}$	0.07	0.21
6	WA ~ facility type + level + district + managing authority	-1476	776	n/a	$5*10^{-5}$	0.07	0.21
7	WA ~ facility type + level + region + managing authority	-1598	812	0.05	$5*10^{-5}$	0.07	0.21
8	PCA ~ facility type + level	-2367	1191	0.05	0.03	0.06	0.21
9	PCA ~ managing authority + level	-2400	1209	.05	$4*10^{-5}$	0.07	0.20
10	PCA ~ facility type + level + district	-2241	1154	n/a	0.035	0.06	0.20
11	PCA ~ facility type + level + region	-2354	1186	0.05	0.034	0.06	0.20
12	PCA ~ managing authority + level + region	-2393	1207	0.05	$5*10^{-5}$	0.07	0.20
13	PCA ~ facility type + level + district + managing authority	-2270	1172	n/a	$5*10^{-5}$	0.07	0.20
14	PCA ~ facility type + level + region + managing authority	-2351	1188	0.05	$5*10^{-5}$	0.07	0.20

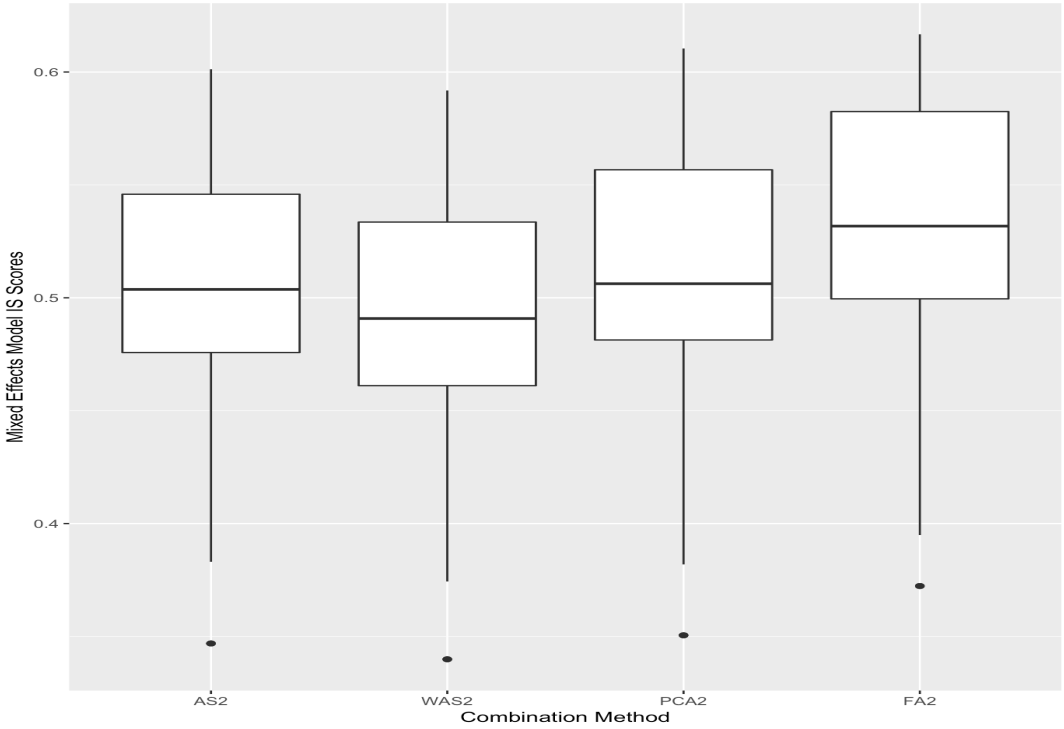
-facility type = hospital or health center; dummy = individual health worker or facility; managing authority = MoH, CHAM, or NGO
*SD refers to standard deviation
**n/a means this level was not included in model

The PCA models had lower AIC and higher log likelihood in Table 5.6, demonstrating better model fit than the other three methods. The best model fit was the PCA model with the fixed effect of managing authority and the individual/facility dummy variable. The random effects columns of this table demonstrate that there is little inter-cluster variation within the district, facility and individual levels from x in y model to r in s model. For instance, the low values in the district column (Table 5.6) indicates that the IS scores of facilities differ little across the districts. There is little change in these effects even as the fixed effects of facility type or level change. However, when the managing authority of the health facility (MoH, CHAM, or NGO) is added as a fixed effect (such as in models 2 or 9), variation at the facility level reduces

tremendously from 0.03 to 0.00006. This indicates much of the variation at the facility level is likely confounded by whether the facility is government, CHAM, or an NGO.

Figure 5.5 shows a comparison of the four sets of scores (SA, WA, PCA, EFA) that use the mixed effects method to combine across health system levels. Similar to the distributions resulting from the simple average combination method, the mean and interquartile range for all four methods have means near 0.50 and exhibit a similar pattern.

Figure 5.5: Boxplots comparing IS scores using MEM heath system combination method across four indicator combination methods

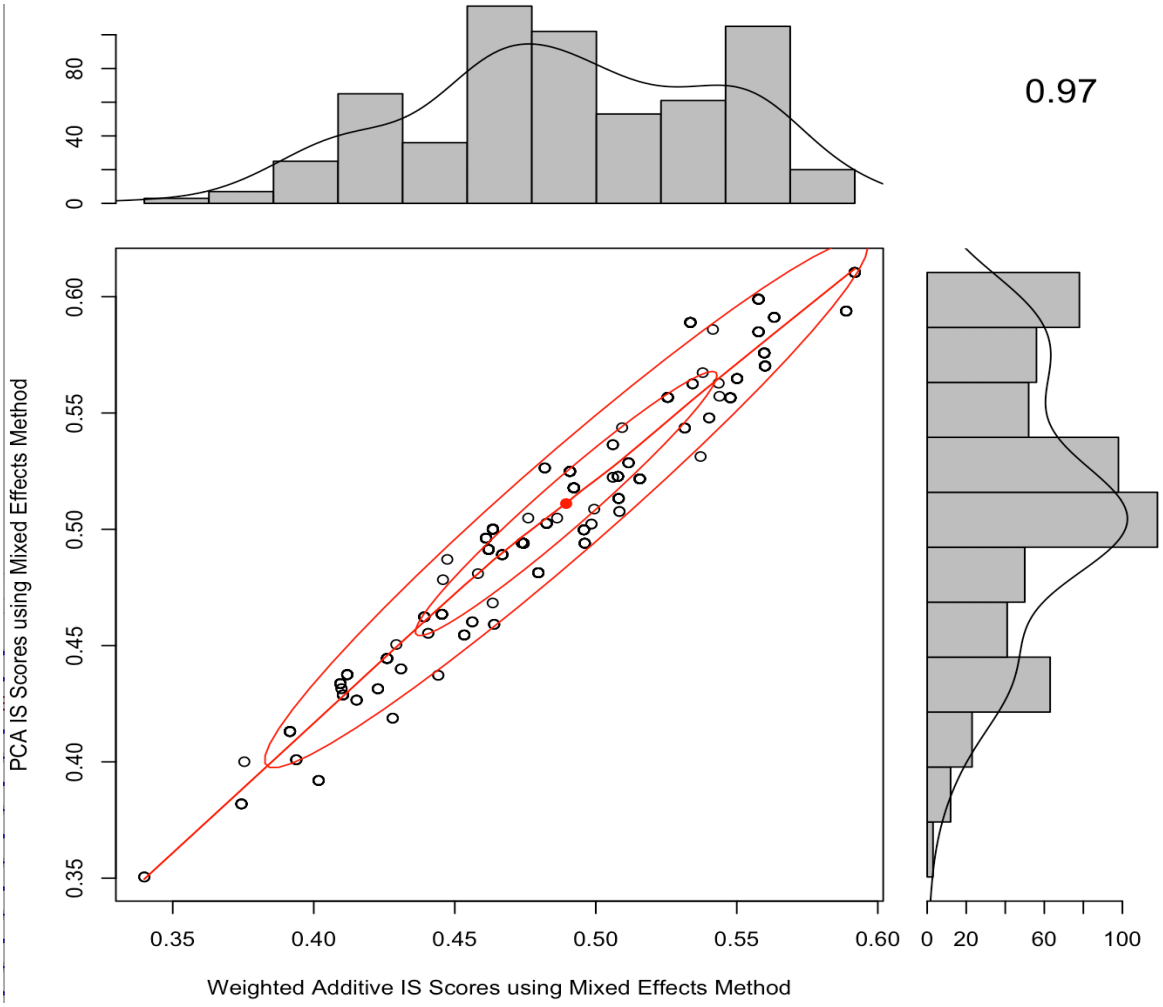


The individual factor loadings for the PCA and EFA methods at the catchment area level can be found in the annex. Cronbach's alpha for internal consistency was 0.88 for both the PCA and EFA at the CA level, indicating that these items are consistently measuring the same underlying construct. Through item analysis, we found that no trimming of any item would increase the

alpha. There was not any single component that accounted for a large share of the variation; all were between 9-14%.

Figure 5.6 below shows a pairwise comparison of the distribution of the weighted additive and PCA index methods using the mixed effects model via a two-way scatterplot. Similar to the simple average WA and PCA score comparison, the correlation coefficient is high at 0.97. When comparing the rest of the score distributions that use MEM, we found a similar pattern of high correlation coefficients across all six comparisons. These scatterplots can be found in the annex.

Figure 5.6: Two-way scatterplot comparing the weighted additive and PCA IS scores that use the mixed effects model



Comparing score distributions between simple average and mixed effects methods

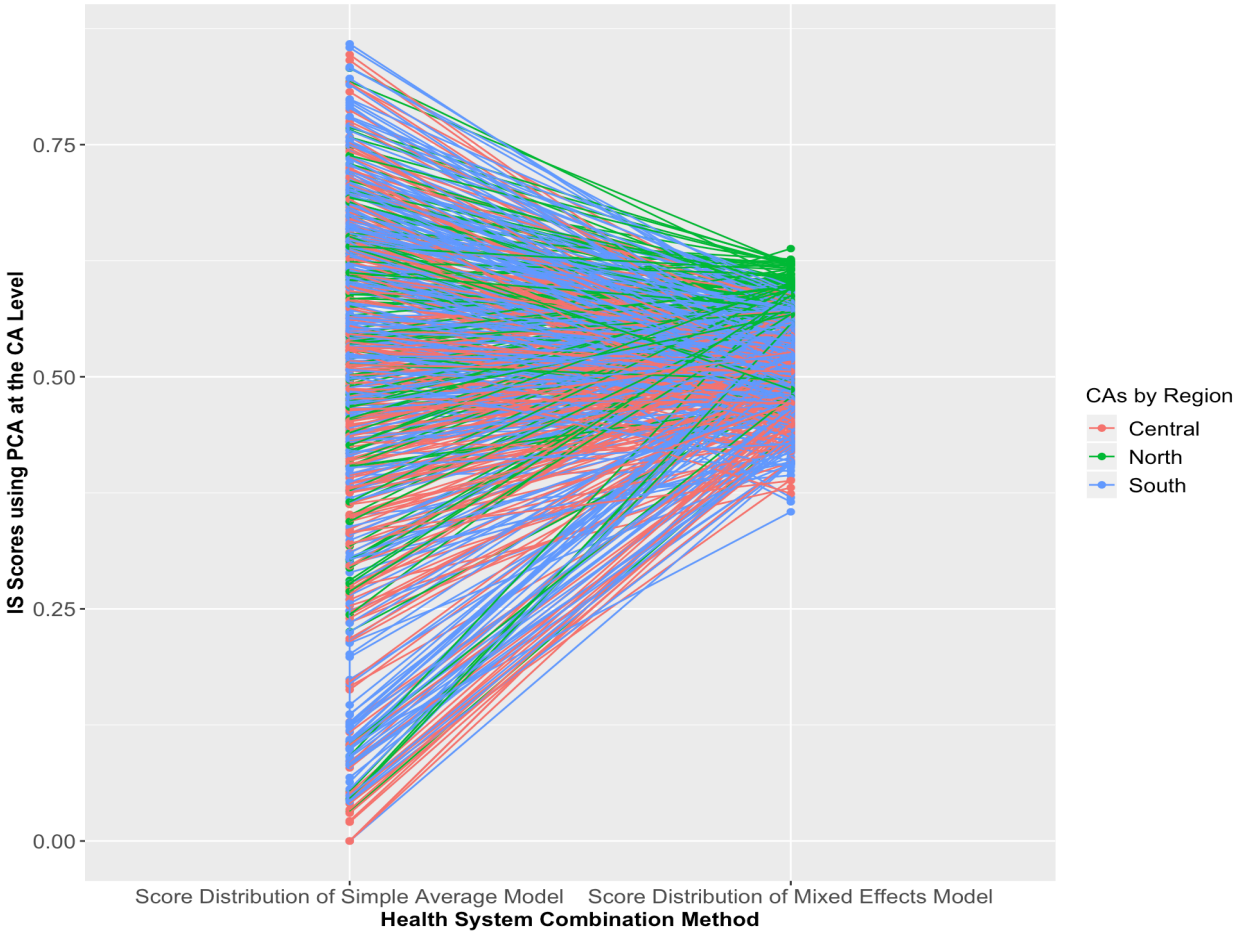
Table 5.7 shows the intra-cluster coefficient (ICC) scores of each of these indices at the district level. All eight of the indices show low ICCs, which indicate that CA scores within districts are no more similar to one another than CA from different districts. This comparison of the ICC of these 8 indices indicates that it should not be a factor in choosing the best method.

Table 5.7: Comparing the intra-cluster coefficient (ICC) between summary measures

Y Variable	ICC
Simple Average Model	
Simple additive	0.064
Weighted additive	0.090
PCA	0.071
EFA	0.058
Mixed Effects Model	
Simple additive	0.077
Weighted additive	0.078
PCA	0.086
EFA	0.076

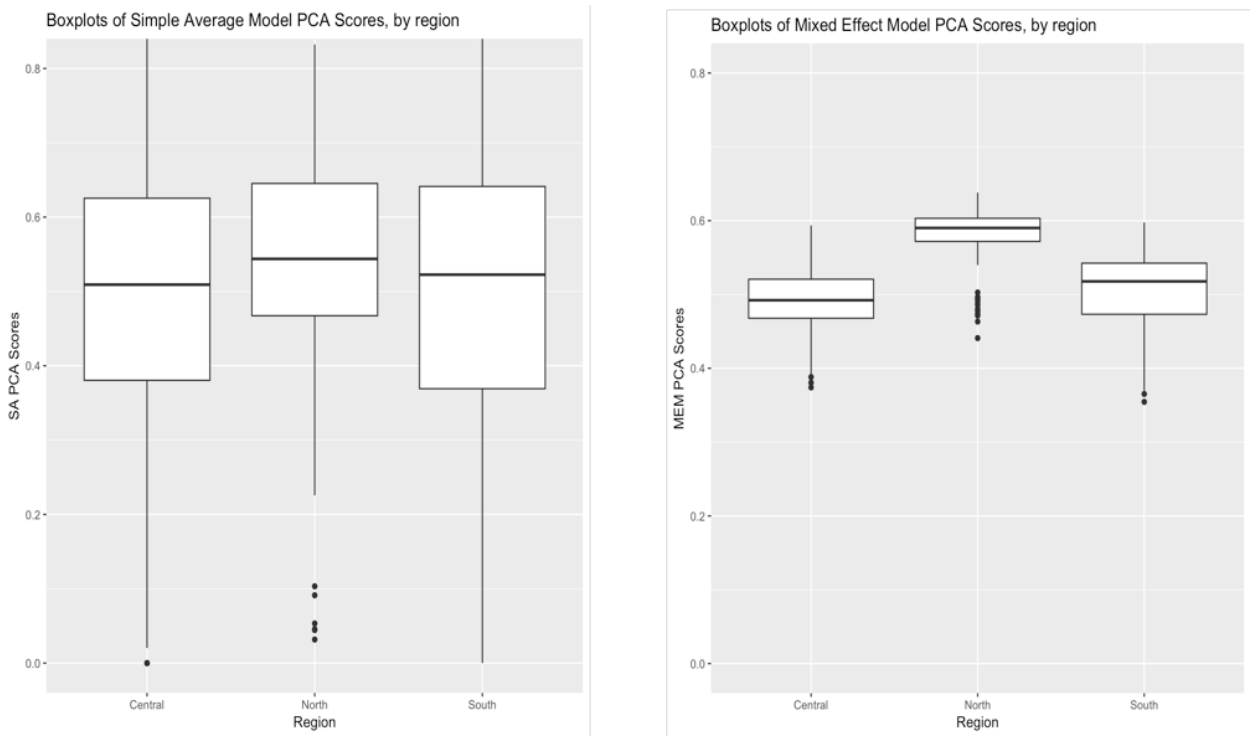
Another way to compare these indices is to look at how the distribution of CA scores, and the standard error associated with these scores, changes in the simple average model versus the mixed effects one. Figure 5.7 provides a pictorial representation of moving from the simple average model on the left to the mixed effects model on the right, using the PCA method.

Figure 5.7: Funneling plot depicting transformation of facility catchment area IS scores from simple average to mixed effect model



The distribution of IS scores for the simple average model ranges from 0 to 1, while the MEM ranges from 0.46 to 0.68. A comparison of all four index methods displayed a similar, shrinking pattern. Figure 5.8 below also depicts the results of the mixed effects model shrinkage. This figure compares the CA scores by regions in Malawi. The shrinking described above is evident again by the range of the boxes in each diagram.

Figure 5.8: Comparison of mean and interquartile range of the ISA scores using the PCA summary method between the simple average and mixed effects model, by region



On the left, the range of scores resulting from the PCA using the simple average model are much larger than those resulting from the mixed effects model. In the diagram on the right, there is a significant difference between the regions. Thus, using the MEM method creates a more discriminatory set of scores than the simple average method.

Figure 5.9 below compares the IS score distributions that result from using the simple average versus the mixed effects models to combine data across health system levels. Both score distributions here use the PCA method to combine across indicators, as this was seen to have the highest model fit in the MEM analysis.

Figure 5.9: Comparing the PCA IS score distributions between the simple average versus the mixed effects model

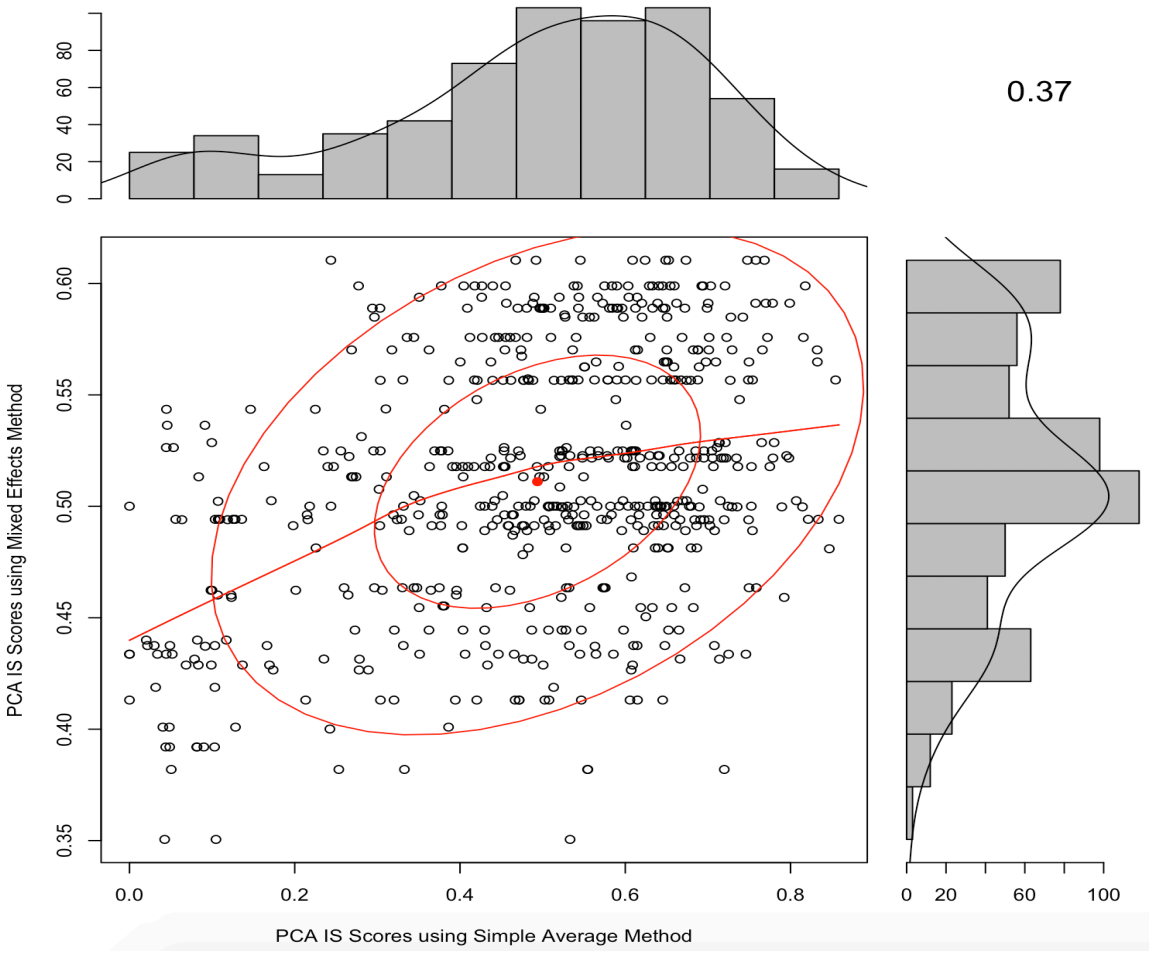


Figure 5.9 suggests that there is low similarity in the scores resulting from the simple average versus the mixed effect models. The correlation coefficient here is 0.37, which is far lower than the correlation coefficients seen when indicator combination methods were compared at separate health system levels in Figure 5.6, for example. Similar comparisons of all the score distributions can be found in the Annex.

Next, we assessed the criterion validity of each health system combination method by observing how the outcome variable of population-adjusted couple-years protection changes with increasing quintiles of IS.

Table 5.8: Change in population-adjusted couple-years protection by quintiles of implementation strength, comparing simple average and mixed effects models

	Average Population-Adjusted CYP	
IS Quintile	SA	MEM
1	16.97	27.17
2	49.42	30.16
3	38.33	30.47
4	36.16	36.73
5	49.24	65.52

Table 5.8 shows that population-adjusted CYP increases dramatically between quintile 1 (16.97) and 2 (49.42) in the simple average model. This outcome then decreases to 38.33 in the 3rd quintile and 36.16 in the 4th quintile in the simple average model, and increasing to 49.24 in the 5th quintile. On the other hand, population-adjusted CYP steadily increases through all five quintiles, though only from 27.17 to 36.73 in the first four quintiles. The outcome then increases dramatically to 65.52 in the highest quintile of IS using the mixed effects model.

Discussion

This study explored different ways to create a catchment area-level summary score for implementation strength of multiple large-scale family planning programs. We used data from the 2017 Malawi ISA that measured the implementation strength of FP programs across supply-side indicators at different health system levels of Malawi. We employed four methods (SA, WA, PCA, EFA) to combine data across IS indicators and two methods (simple average, mixed effects) to combine data across health system levels.

When comparing summary statistics and score distributions, we found that there was little difference in how the four indicator combination methods captured variation of the IS data at the

individual and combined levels of the health system. In other words, there was little difference in the four distributions at the health facility and worker levels separately, and also little difference when comparing the four distributions within the simple average and within the mixed effects combination models. In fact, there was much higher agreement between the four models in this study than the previous studies we reviewed that compared summary measures.[163,179]

However, we found major differences between how the simple average and mixed effects models assign scores for health facility catchment areas. We found that the MEM model shrinks the distribution of catchment area IS scores, resulting in very little similarity in the scores between the two models. Additionally, the scores resulting from the MEM model were more discriminatory than the scores resulting from the simple average technique. We also found that as MEM IS scores increase, CYP also increases in a more stable, positive linear pattern as opposed to the simple average IS scores. This points to the MEM scores being a better predictor of intended impact, though more research needs to be done to corroborate this finding.

There are several factors to consider when choosing between the four methods that combine across IS domains and indicators. While the simple and weighted additive methods are relatively easier to calculate and interpret, they have a number of limitations. The simple additive method assigns equal weights to each indicator and thus, could over- or under-weigh certain indicators. It also does not account for any collinearity between indicators or across domains. The lack of granularity seen in the heaping of scores in the distributions as well as the unidimensionality of the SA lead us to not recommend a simple additive summative measure to summarize ISA data.[163]

The weighted additive method addresses some of these concerns by accounting for collinearity within a domain via weighting. However, these measures still rely on significant expert input in choosing what domains and indicators should be included and how they should be grouped. If future studies aim to use additive measures in the future, we recommend that a more rigorous process of expert feedback, such as a Delphi method, is utilized.[162,180]

Using a PCA or EFA to combine data across IS indicators is undoubtedly more complex to calculate and more difficult to interpret. There are several considerations (e.g. factor extraction, rotation, components to retain) in constructing the score from a PCA or EFA that require a strong understanding of the method.[170,181,182] Yet, the weighting issues in the additive options do not apply with these factor analyses. The number of components or factors to retain, which serve as analogues to the domains in the additive models, comes from the underlying variation of the data itself. While the indicators within the components/factors were similar to what the experts chose for domains in the additive methods, there were key differences especially in the accessibility and supervision domains, as well as between health worker levels. In our study, the variation is explained in both the PCA and EFA by five components and factors. Other studies have often used only one or two components or factors, but the majority of variation in their data was explained by these components/factors.[163170,183] Otherwise, only using one component or factor can lead to a misclassification in scoring.[165] In our study, the variance was fairly evenly distributed among the first five components/factors at both the CHW and HF levels.

A drawback of how we calculated the PCA and EFA scores is that they are context specific.[163,165] The loadings used for each only apply to this dataset and thus need to done again with any other data. The major difference between these two methods is that the EFA factors represent a latent structure of the data, while the PCA components do not. Since the distributions between the PCA and EFA scores were very similar, we recommend the simpler PCA. It is easier to calculate, as well as being more flexible and generalizable. If data reduction is the goal, and not measuring a latent variable, than PCA is recommended.[170,184,185] For instance, if future studies don't include the training domain, then this would have less impact on a PCA than an EFA. Moreover, goodness-of-fit tests in the MEM were higher in the PCA models than the EFA ones.

There are several factors to consider when deciding between the simple average and mixed effects method of combining data across health system levels. As the name suggests, the first technique of simple average is easier to construct because the CHW scores associated with each facility are averaged and inserted into the final equation of the score. However, this can lead to more inaccurate measures especially when there are few CHWs per facility. For instance, if a facility has two associated CHWs and one has high IS and the other has low IS, the contribution to the catchment area score for that facility will inaccurately be in the middle of these two CHW scores for this method.

The MEM model, on the other hand, accounts for this. This Bayesian model uses prior information from similar health facilities and workers to create a posterior distribution of IS scores. The MEM technique borrows information from similar CAs to the CAs with high standard error. In doing so, it results in fewer extreme values and possibly more accurate

representations of implementation strength of FP programs. We reviewed AIC and log likelihood to assess model fit and random effects in the MEM for clustering at the district, facility, and individual levels. We found that the WA and PCA models had the best model fit statistics and lowest residual variance. As discussed earlier, the MEM scores were more discriminatory and predictive of CYP than the simple average one. Thus, if added complexity in calculation and interpretation is not an issue, the MEM combination method seems to outperform the simple average one.

Many studies reviewed used multi-level modeling in FP or maternal and child health research, but none encountered combined facility and individual provider level data to create a combined score.[186,187] Several studies took the health system into account by including whether a facility had CHWs in the construction of their facility-level summary measure. [164,165,188] But this study accounts for worker contribution purposefully and explicitly, by creating separate scores for individual health workers and then combines them with the facility, rather than including a HW indicator in the facility score itself. Another option that other QoC studies have explored is creating summary measures for each individual domain or analyzing individual indicators, rather than constructing a summary measure across multiple domains.[165,189,190] This study was unique in that it explored options to combine data both across indicators/domains and health system levels. Of course, the decision whether to construct and use a summary measure depends on the question the study is trying to answer. Other studies may want to explore the effect of a specific intervention that trained HSAs in Malawi on YFHS. On the other hand, the explicit objective of this study was to construct and compare summary measures that capture the sum effect of several FP programs or interventions implemented at multiple levels of the health system.

This summarized IS score can be used to understand the combined impact of a set of FP programs, identify patterns in IS across CAs and districts, and assist with targeting priority areas for future implementation. For instance, leadership in a District Health Office in Malawi can review the IS scores across their district to quickly understand how performance differs by CA, dig deeper into what may be the cause of it, and/or where they should prioritize resources or programmatic components. This leadership can also analyze how IS scores change by key covariates, such as managing authority or facility type. Still, we acknowledge that to construct this score is not a simple task and the interpretability can be difficult, especially to those not familiar to these types of methods.

Future research can explore how to make these methods accessible to local decision-makers. Additionally there is a need to explore how IS scores differ across countries, as context and systems likely play a key role in how a program is delivered. Repeated application of the ISA can also allow for analyzing the change in IS at the CA level over time. Due to the relatively simple indicators whose data can be collected via short phone interviews or even routine data, tracking IS scores across time can give decision-makers a valuable tool in assessing progress towards their objectives. The ultimate and explicit objective of these FP programs is to positively impact these outcomes down the impact chain. Future research can also explore the associations these IS scores may have with key FP outcomes further down the impact chain than CYP, such as modern contraceptive prevalence rate (mCPR) and demand satisfied for FP.

Limitations

The data used from the 2017 Malawi ISA may not capture every intervention that was recently implemented to improve FP outcomes across Malawi. We aimed to capture the major interventions after review of the local policies and input from local leadership in the government, CHAM, and leading NGOs. Also, the numerous policies and programs were on different stages of their implementation, which means that the quantity delivered could vary based on the stage of the program. We tried to account for this by only including programs that were being implemented in the last two years. In fact, most ISAs evaluate implementation strength of a specific program rather than a national strategy.[115,152,156]

Furthermore, we were limited in the scope of questions allowed by the data collection method of the ISA, which was via mobile phone interviews. Thus, the questions needed to be relatively simple, primarily yes or no. This limited the ISA to not include process indicators, which detail the nature of care received by the client. There could be real quality issues not captured by the ISA; for instance, even if a health facility has a high IS score, its health workers could be providing poor quality care in person to the client that the ISA does not capture. Even for the structural indicators chosen, they were chosen with feedback from local and content experts, but a rigorous Delphi-type approach was not used due to time and capacity constraints.

There is timing inconsistency when adjusting CYP (calculated from the 2017 Malawi ISA) by catchment population data from the 2008 Malawi census. Population-adjusted CYP as calculated in this study is likely overestimated due to the population in each catchment area likely increasing over the last decade. We recommend re-adjusting CYP when the 2018 Malawi census report is released.

Conclusions

The ultimate aim of this study was to elucidate the key choices to be made at different points of the process in constructing an IS score at the catchment area-level and the statistical corollaries of each decision. Summarizing implementation strength of FP programs into a score for each health facility's catchment area can aid decisionmakers in understanding the sum effect of the myriad of FP programs being implemented in their health systems. The findings of this study suggest that using a principal components analysis to combine data across indicators and a mixed effects model to combine data across health system levels will produce the most accurate set of IS scores at the catchment area level. This can then serve as an evidence-based platform to target areas with weaker IS, especially in low and middle-income contexts where resources and capacity may be constrained.

Chapter 6: The aggregate effect of implementation strength of family planning programs on modern contraceptive use at the health systems level in Malawi

Background

Controlling the growth of population is a concern for many countries, especially those in sub-Saharan Africa where fertility rates are higher than any other region in the world.[149] These national governments aim to achieve the demographic dividend, which would result in an age structure with more of the population of working age and less as dependents. In turn, this could spark much-desired economic growth in these low-income countries.[191,192]

Recent literature has shown that increasing the accessibility and readiness of the health system through programs that target training, supervision, method choice, or demand generation activities can have a positive impact on modern contraceptive rates (mCPR).[171,193,194] Another key strategy is to increase the density of health workers providing FP, including community health workers (CHWs).[195,196] Hence, a common strategy for governments has been to implement large-scale family planning (FP) programs that include these interventions in order to increase modern contraceptive use and ultimately curb population growth.[133,134,197]

This study aims to test the association between the implementation strength of a government's FP program, or the quantity delivered, and its impact on mCPR. While there is research that analyzes how readiness and structural quality can be linked to family planning outcomes, there is little that tests the impact of a program's implementation strength.[163,165]

To test this, this study utilizes data from the 2017 Malawi Implementation Strength Assessment (ISA) of FP programs.[153] Malawi has been implementing multiple national and subnational FP policies and programs in order to increase mCPR, especially among their large youth population.[49,53,58] They have also been increasing their density of health workers, which is especially vital in Malawi as certain types of CHWs are allowed to provide injectables (the country's most popular contraceptive method).[55]

The 2017 ISA assessed how much of Malawi's national FP strategy had been implemented at the facility and CHW levels across the domains of training, supervision, method choice, demand generation activities, and accessibility.[153] Paper 2 used this data to construct and compare

different techniques to construct an IS score that combines data across indicators and across health system levels to understand the combined effect of the implementation of Malawi's FP programs at the health facility catchment area level. This study uses the final recommendation of an IS score from that study to test the effect of IS on modern contraceptive use in Malawi. This outcome was chosen because it is the most proximate outcome indicator of the type of FP programs the ISA assessed and it is the main objective of recent MoH FP strategies and programs in Malawi.[49,53,198]

In order to test this association, we linked IS data from the 2017 ISA and FP outcome data from the 2015 Malawi Demographic Health Survey (DHS). We used linking methodology recommended from Peters et al (2018), which reviewed several techniques to link the 2017 ISA and the 2015 Malawi DHS.[199] Using this linking approach, this paper aims to show that stronger implementation of FP programs leads to increased use of modern contraceptives among rural women in Malawi. This analysis can help planners and practitioners understand the aggregate effect of large-scale FP programs on key outcomes, what factors can influence this association, and can inform evidence-based adjustments. It can also add to the evidence base demonstrating the connection between improving structural quality and increased modern contraceptive use.

Methods

This study draws from two data sources from Malawi: the 2017 Implementation Strength Assessment of FP programs (ISA) and the 2015 Malawi Demographic and Health Survey (DHS).

Data source for independent variable

The ISA was a mobile phone-based survey conducted from May to July 2017 that aimed to understand how strongly FP programs, especially those directed at youth, were being implemented at the health facility catchment area level across Malawi. Data were collected not only from all health facility In-Charges (ICs) and workers (HFWs), but also from Malawi's two sets of community health workers that provide FP: Health Surveillance Agents (HSAs) and Community-Based Distribution Agents (CBDAs).

Data were collected across five domains: training, supervision, contraceptive method and supply availability, demand generation activities, and accessibility. This data is used to create the main independent variable in this study: an implementation strength score for each facility's catchment area. For more detail on the data collected for each indicator within these domains, please refer to Chipokosa et al.[153]

Creating an implementation strength score for each health facility's catchment area

In Paper 2, we created this IS score by (1) combining data across indicators and domains; and (2) combining data across health facility (IC and HFW) and community health worker (HSA and CBDA). This paper explored a variety of options for creating such a summary score and recommended the best option, which will be used in this study.

The best option for combining data across IS indicators and domains identified in Paper 2 was a principal components analysis (PCA). PCA is a technique that reduces the number of observed variables to a smaller number of principal components that account for most of the variation of the observed variables. The most accurate option to combine data across health system levels

was to use a Bayesian mixed effects model (MEM), which can account for any clustering at the district and facility levels.

The final step in the construction of an IS score is to funnel these scores through the density of health workers providing FP in a catchment area. The numerator for this density indicator is the numbers of health workers associated with each facility, which comes from the ISA. The denominator for HW density is each facility's catchment area population, which are retrieved from the 2008 Malawi census.[177] This allows for the IS score for a CA to be adjusted by the density of HWs in that CA.

In this study, this score represents IS at the CA level and will be used as an independent variable in a regression with key FP outcomes from the 2015 Malawi DHS. We will cut the IS score into quartiles in order for easier interpretation and comparison using figures such as GIS maps.

Data Source for Dependent Variable

The 2015 Malawi DHS is a nationally representative survey that was implemented by the National Statistical Office from October 2015 to February 2016 in joint collaboration with the MoH and the Community Health Services Unit. It provides national, regional, urban/rural, and district estimates for household and respondent characteristics as well as key health statistics, including family planning and fertility.[55]

This DHS employed a stratified two-stage cluster design that resulted in a total of 850 enumeration areas (or clusters), consisting of 26,261 households with 24,562 female

respondents. To protect the confidentiality of survey participants, the DHS displaces the geocoordinates of the clusters from their original location. Coordinates for rural clusters were randomly displaced up to 5 km away, while urban clusters were displaced up to 2 km away. One percent of these rural clusters were randomly displaced up to 10 km away.[55]

The dependent variable in our study, whether a woman is using a modern contraceptive, is from this DHS. We used the DHS definition of mCPR, which is defined as any woman using male condoms, female condoms, oral contraceptive pills, injectables, implants, IUDs, male and female sterilization, and emergency contraception at the time of interview.[55] Traditional methods such as calendar/rhythm methods and withdrawal are not considered modern contraceptive methods.

The following control variables were also chosen from this DHS after carefully after reviewing the literature, of other common predictors of mCPR: age, education, region, religion, and wealth of individual women.[160,163,166,171]

Linking ISA and DHS datasets

The linked method chosen for this study was developed by Peters et al using the 2017 Malawi ISA data. This method involves creating 5 km buffers around DHS cluster centroids and pinpointing the number of health facility catchment areas that fell within these buffers. Peters et al developed a technique to estimate catchment areas for each health facility, which includes the facility and the village clinics and outreach posts where CHWs provide FP.[199]

In some cases, these buffers captured several catchment areas. In order to link DHS clusters with IS scores, we followed Digitale et al by averaging the IS scores from the multiple facilities linked to a single cluster.[200] As a result, each DHS cluster (and the individual women within them) was linked with a single IS score, which is an average of the facilities in that cluster.

Urban service environments in Malawi have higher facility density, more private and informal options, and transportation is less of an issue. Thus, a woman being geographically close to a facility can be an inconsistent predictor of service utilization in urban areas.[201] Hence, we restricted our dataset to only rural DHS clusters as classified by the DHS in its sampling strata. In fact, over 80% of the women in Malawi are designated as living in rural areas. After removing the urban clusters, the resulting dataset is comprised of 675 clusters with 19,261 women.

Analysis

We used a mixed effects model (MEM) to test the association between implementation strength and modern contraceptive use among rural women at the CA level. This method allows for analysis of fixed and random effects and to account for any clustering at the DHS cluster level.

$$\mathrm{Y} = \underbrace{X\beta}_{fixed} + \underbrace{Zu}_{random} + \varepsilon$$

where

- y is the n-by-1 outcome vector, and n is the number of observations.
- X is an n-by-p fixed-effects design matrix (predictors)
- β is a p-by-1 fixed-effects vector (regression coefficients).
- Z is an n-by-q random-effects design matrix (random complement to the fixed x)
- u is a q-by-1 random-effects vector (random complement to the fixed β)

- ε is the n-by-1 residuals vector (part of y not explained by model)

The fixed effects in this model are the IS scores and the control variables listed earlier. The outcome is whether a rural woman is currently using a modern contraceptive. Unadjusted and adjusted logistic regression models are compared; thus, we estimated odds ratios (ORs) and 95% confidence intervals (CIs) in the regressions. We employed stepwise regression models to better understand how the control variables influence the association between IS and mCPR. We also ran models with interaction terms if any of these showed significance to test for effect modification. All analysis was conducted using R 3.4.1 software.[178]

Results

The 2017 Malawi ISA interviewed 660 of 666 health facility ICs (99%), 1691 of 1826 HFWs (93%), 3092 of 3314 CBDAs (93%), and 3547 of 4346 (82%) HSAs, which was over its 80% quota.[153] This study only used facilities and their associated health workers that were linked with rural DHS clusters. This resulted in 675 DHS clusters (out of 815) and 497 facilities being retained. Table 6.1 describes the characteristics of these remaining facilities used in this study.

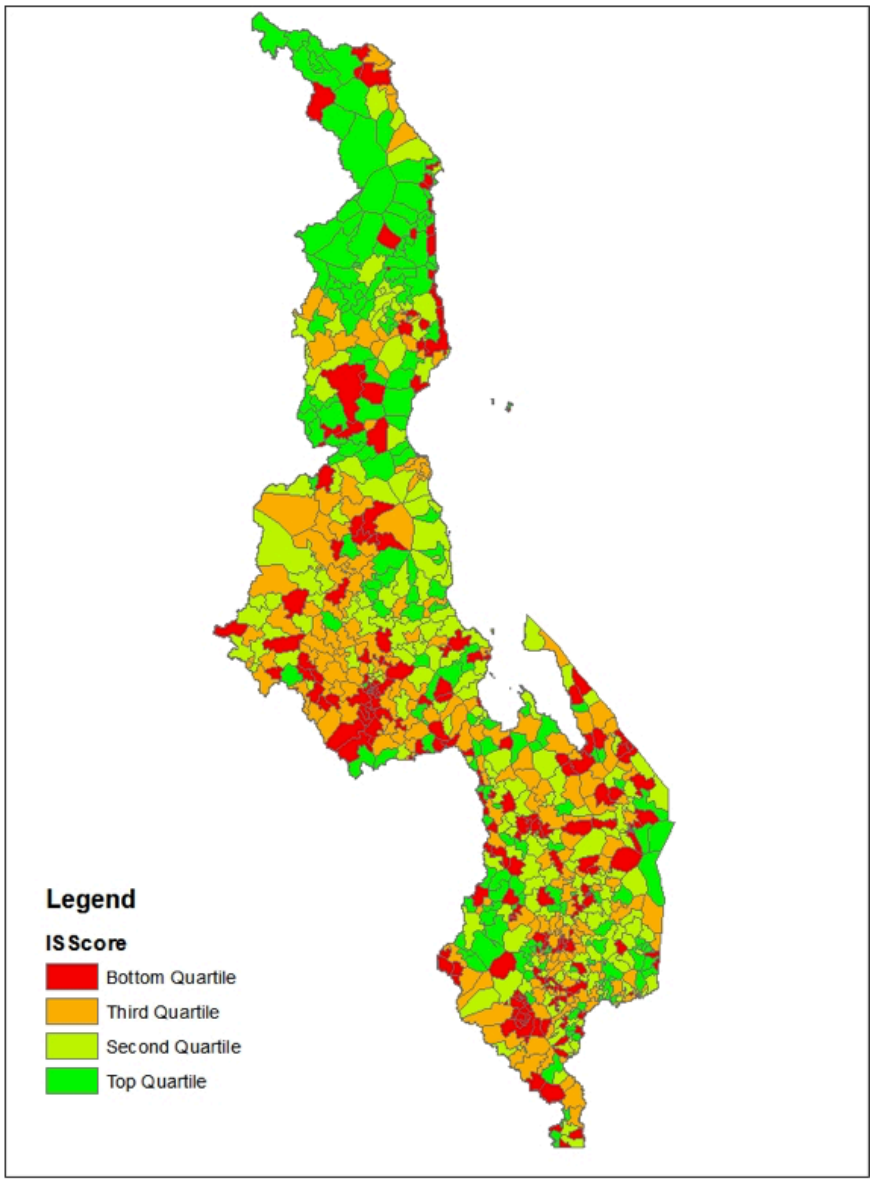
Table 6.1: Background characteristics of health facilities used in study

	n (%)
Total number of health facilities retained	497
Proportion of facilities that are health centers (%)	455 (91.5)
Managing authority of health facility (%)	
MoH	362 (72.8)
CHAM	120 (24.1)
Other	15 (3.0)
Region (%)	
North	84 (16.9)
Central	191 (38.4)
South	222 (44.7)

Median # of health workers per facility	
HFWs	2
HSAs & CBDAs	11

Of the rural facilities used in this study, 73% of them are government health centers, with CHAM facilities only comprising 24% of facilities. The Northern region has the lowest proportion of facilities (16.9%) compared to the other regions, which is consistent with population. On average, these facilities have about 3 workers providing FP in the facility and 14 workers providing FP in the community. From this data, an IS score was calculated for each rural facility's catchment area. The heat map in Figure 6.1 below displays how IS scores for each DHS cluster are distributed across Malawi. The scores are cut into quartiles (i.e. top quartile means highest IS) and color coded for easier interpretation.

Figure 6.1: Heat map of IS scores, by quartile, within each DHS cluster across Malawi



More CAs in the northern region are in the top quartile, while the Central region seems to have more in the lowest one. The Southern region also displays many CAs that are in the bottom two quartiles. Note that this figure includes the urban catchment areas that we did not link to DHS clusters to test the association between IS and modern contraceptive use. Table 6.2 describes the characteristics of the 19,261 women that provided data within the matched rural clusters from the DHS. This table also lists the mCPR among rural women within the different levels each category.

Table 6.2: Background trait of women in rural DHS clusters and associated mCPR for each trait

Characteristic	n (%)	mCPR of rural women
Total no. of women	19,261	46.0
Age		
15-19	4141 (21.5)	15.8
20-24	3969 (20.6)	48.0
25-29	2994 (15.5)	58.8
30-34	2824 (14.7)	58.7
35-39	2391 (12.4)	60.1
40-44	1646 (8.5)	52.8
45-49	1296 (6.7)	42.4
Education		
No education	2555 (13.3)	47.1
Primary	12920 (67.1)	47.0
Secondary	3581 (18.6)	41.4
Higher	205 (1.1)	37.1
Marital Status		
Currently married	12862 (66.8)	58.2
Formerly married	2640 (13.7)	37.7
Never married	3759 (19.5)	9.5
Region		
Central	6582 (34.2)	47.5
North	3673 (19.1)	45.8
South	9006 (46.8)	44.7
Religion		
Catholic	3433 (17.8)	47.3
Other Christian	13544 (70.3)	47.1
Muslim	2155 (11.2)	36.1
Other/No religion	129 (0.7)	44.9

Nearly 67% of rural women in Malawi are currently married and mCPR increases dramatically from rural women who have never been married to those who are married. About 67% of rural women have only a primary education, which also has the highest mCPR in this category. About 70% describe themselves as Christian (excluding Catholics), while Muslim women have the lowest mCPR. Over 40% of rural women in Malawi are also under the age of 25 and mCPR

decreases dramatically between the 20-24 and 15-19 age groups. While 47% of all rural women live in the Southern region, mCPR is similar across the regions.

As seen in Table 6.2, both unadjusted and adjusted models show that a woman has higher odds of using a modern contraceptive as the IS score of their catchment area increases. The confidence intervals for the IS score variable are larger than the other variables because the IS scores come from the smaller, ISA dataset. The other variables all come from the DHS, where there are nearly 20,000 observations for women.

Table 6.3: Odds ratios and confidence intervals for women using modern contraceptives and implementation strength score, unadjusted versus adjusted models with random effects

	Response – mCPR of rural women aged 15-49 in Malawi			
Predictors	**Unadjusted Model**		**Adjusted Model**	
	OR	CI	OR	CI
Fixed Effects				
(intercept)	0.80***	0.75-0.86	1.43	1.20-1.71
IS Score	1.98	0.89-4.37	5.32**	1.88-15.07
Age				
15-19			0.35***	0.31-0.41
20-24			0.78***	0.70-0.87
25-29			1.04	0.87-1.07
30-34 (ref)			na	na
35-39			1.11	0.88-1.09
40-44			0.83**	0.73-0.94
45-49			0.55***	0.47-0.63
Education				
No education (ref)			na	na
Primary			1.19***	1.08-1.31
Secondary			1.13	0.99-1.29
Higher			0.76	0.54-1.07
Marital Status				
Married (ref)			na	na

Formerly married		0.42***	0.38-0.46
Never Married		0.12***	0.11-0.14
Region			
Central (ref)		na	na
North		0.76***	0.65-0.88
South		0.91*	0.82-1.00
Religion			
Catholic (ref)		na	na
Other Christian		0.91*	0.83-0.99
Muslim		0.58***	0.51-0.68
No religion/Other		0.73	0.50-1.08
Wealth			
Poorest (ref)		na	na
Poorer		1.18**	1.06-1.31
Middle		1.21***	1.09-1.34
Richer		1.16**	1.05-1.30
Richest		1.18**	1.06-1.33
Random Effects			
DHS Clusters			
Variance	0.12	0.14	
No of Clusters	675	675	
No. of Observations	19,261	19,261	

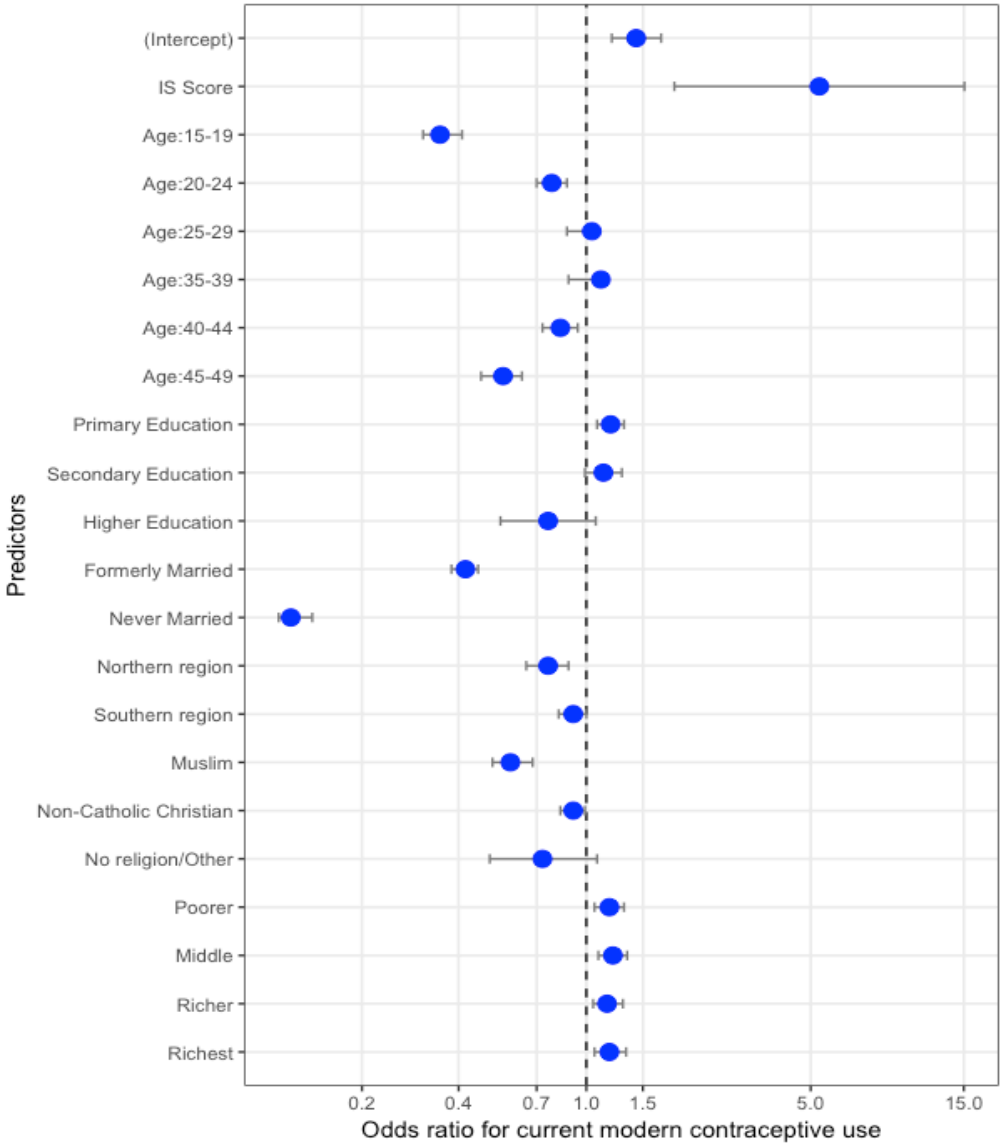
*p<.05. **p<.01. ***p<.001. Notes: ref=reference group. na=not applicable.

Figure 6.2 displays the odds ratios of the adjusted model and how they compare to one another. We found clustering at the DHS cluster level of 0.12 in the unadjusted model and 0.14 in the adjusted model. Those who had primary (1.19***) or secondary education (1.13) had higher odds of using a modern contraceptive than rural women who had no education; though those who had higher education had lower odds (0.76) than the reference group. We also found that education does not modify the effect between IS and modern contraceptive use among rural women.

In comparison to the reference group of Catholic women, Muslim (0.58**), non-Catholic Christians (0.91*), and those with no religion/other (0.73) had lower odds of using a modern

contraceptive. The relationship between IS and modern contraceptive use did not significantly differ between the different religious groups measured.

Figure 6.2: Odds ratios and confidence intervals for women using modern contraceptives and implementation strength score

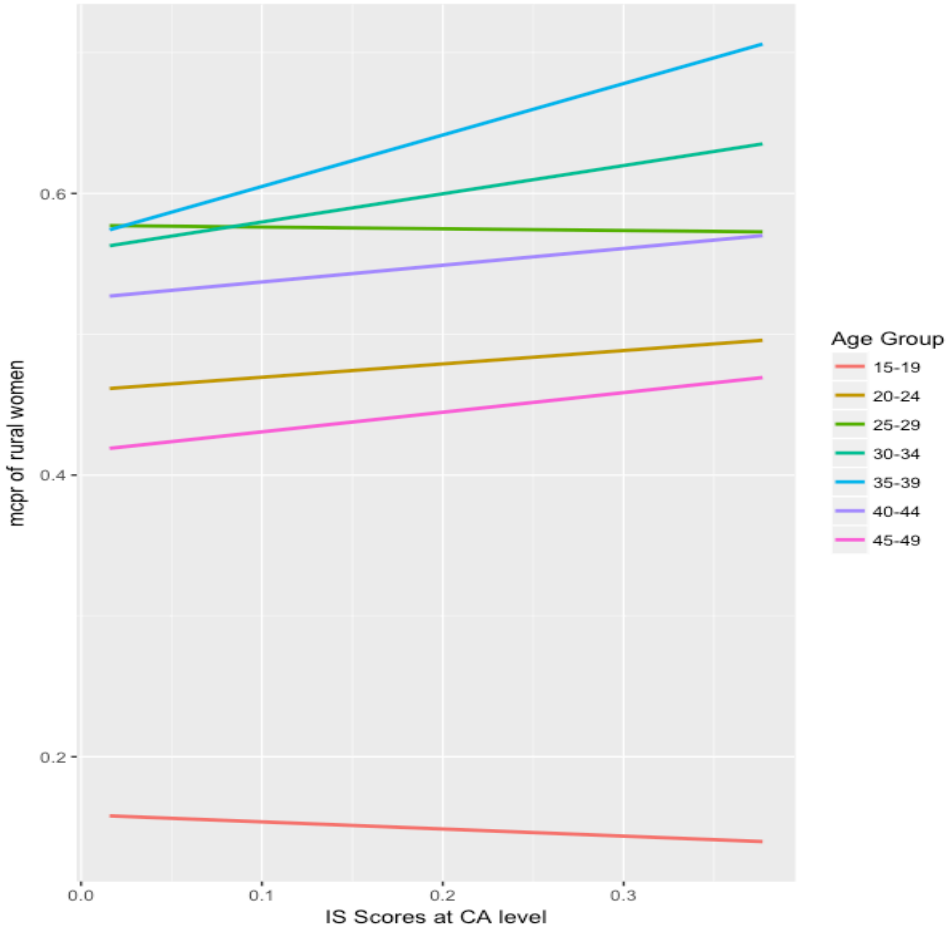


For age, we used the 30-34 age group as the reference because this had the largest, most stable population in which to compare the other groups. Odds of women using a modern contraceptive aged 15-19 (0.34***) and 20-24 (0.78***) were significantly lower when compared to the 30-34

age group. The same pattern was seen for the women aged 40-44 (0.83**) and 45-49 (0.55***). Women who were formerly married (0.42***) or never married (0.12***) had significantly lower odds of using a modern contraceptive than those who were married.

Figure 6.3 depicts the relationship between the IS scores at the CA level and modern contraceptive use among rural women for all seven age groups in the DHS. The 15-19 and 25-29 age groups show a negative relationship between increasing IS scores and modern contraceptive use among rural women, whereas all the other age groups show a positive one. However, none of the age groups were significant when tested for effect modification.

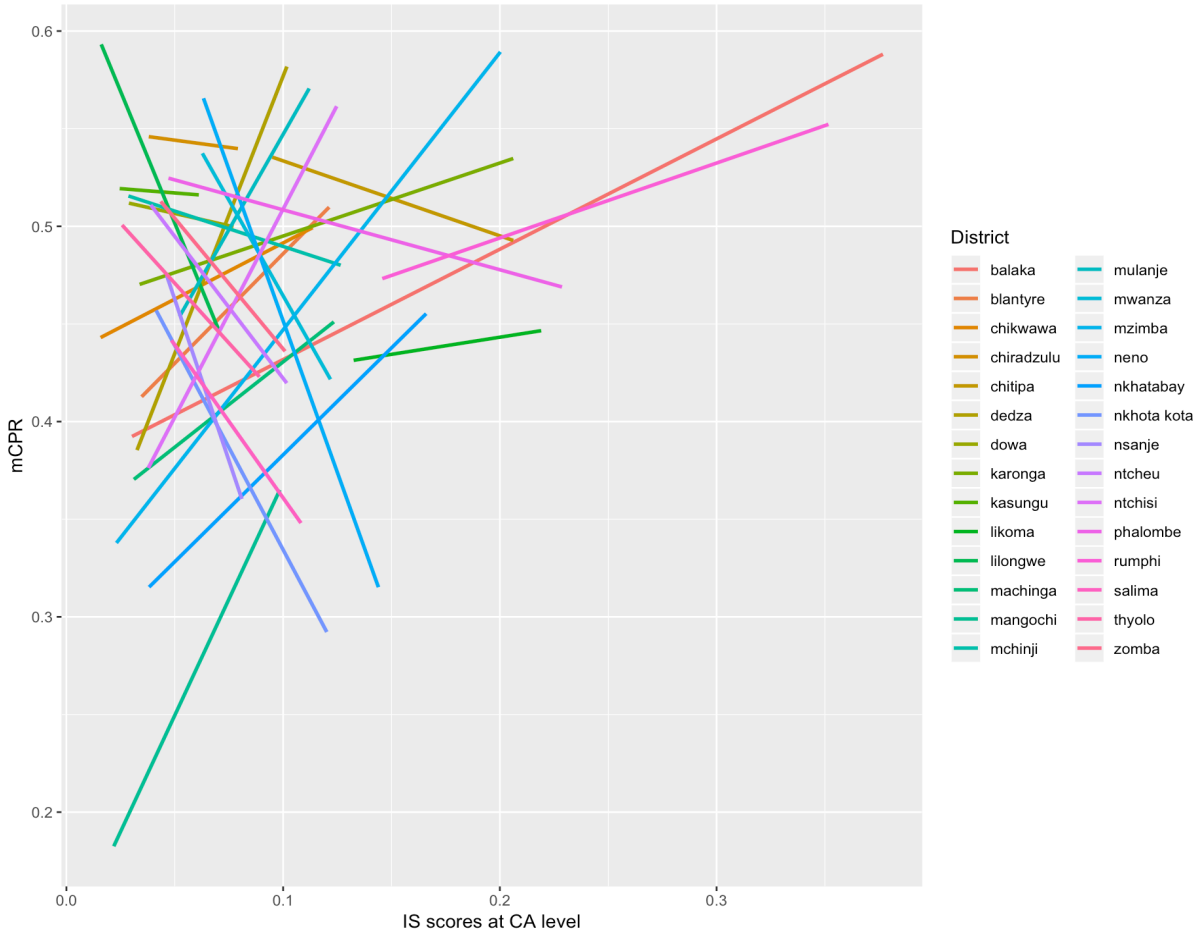
Figure 6.3: Relationship between implementation strength score and modern contraceptive use among rural women, by age groups



Rural women in all wealth quintiles had significantly higher odds of using a modern contraceptive than the poorest women. Though the relationship between IS and modern contraceptive use among rural women was not significantly different between the wealth quintiles. Rural women in the North (0.76***) and South (0.91*) had lower odds of using a modern contraceptive than rural women in the Central region.

To see what may be driving these regional differences, Figure 6.4 below depicts the relationship between IS and modern contraceptive use among rural women across the 28 districts of Malawi. The figure demonstrates how heterogeneous the relationship is from district to district; there are many that suggest a highly positive relationship, while other districts seem to demonstrate a flat or even highly negative association.

Figure 6.4: Relationship between implementation strength score and modern contraceptive use among rural women, by district



The only control variables that showed a significant interaction were the regions and districts. When testing for effect modification among the districts, we found that only the Central districts of Lilongwe and Nkhota kota and the Southern districts of Mangochi, Mwanza, and Neno had significantly different relationships between IS and modern contraceptive use.

Discussion

In this study, we tested the association between implementation strength of FP programs and modern contraceptive use among rural women at the catchment area level. We linked the IS scores for each CA we constructed from the 2017 ISA and modern contraceptive use among rural women from the 2015 DHS in Malawi using the linking method recommended by Peters et

al. The findings from this study suggest that strengthening implementation of FP programs leads to higher odds of rural women using modern contraceptives. In fact, we observed a three-fold increase in the odds ratio moving from the unadjusted to the adjusted models and the relationship became statistically significant. The inference being that controlling for the other common predictors of modern contraceptive use unveils the true, much stronger effect of IS on the odds of a woman using a modern contraceptive.

There have been mixed results among studies aiming to demonstrate a link between structural quality or readiness (an analogue to IS) and contraceptive use.[202,203,204] Most of these studies are restricted to health facility data (often from Service Provision Assessments) and do not take outreach services into account in the manner that this study does.[163,165,200] Additionally, this study fills a gap by analyzing how the combined strength of several FP programs being implemented at once can have a summative impact on modern contraceptive use in a low income setting. Most other studies we reviewed analyze either specific programs or the access and/or readiness of health facilities, outreach separately, or contraceptive methods.[198,205,206]

This study found that education, marriage, and region were the control variables that had the largest attenuating effect on the relationship between IS and modern contraceptive use among rural women in Malawi. This is consistent with recent literature which found that increasing education among women, especially rural ones, has a large effect on demand and mCPR.[55,198,205] This finding adds to the debate about whether FP programs and services or development investments (such as education) are driving changes in contraceptive use and fertility.[73,207,208]

Similarly, cultural norms about marriage likely play a major role in the contraceptive decisions among these women.[55,198,200]

This study also suggests that there is significant heterogeneity in the relationship between IS and modern contraceptive use across the 28 districts in Malawi. In fact, five districts showed significantly negative relationships. Potential reasons for this could stem from what other health and social programs are being implemented in these districts, as considerable government authority as well as NGO implementation takes place at the subnational level in Malawi. These contextual factors that were not accounted for in our analysis could be affecting the relationship we see between IS and modern contraceptive use in these districts.

While age didn't seem to be a key driver of this increased OR, there were significant differences in the relationship between age groups of rural women and modern contraceptive use; Figure 6.3 depicted these differences. Interestingly, the steepest slope seems to be for the 30-34 age group, which suggests that stronger implementation of FP programs has the biggest impact on these women. This could be true as women at this age have had likely had several children and are seeking a modern contraceptive from the formal health system, without fear of stigma like the lower age groups.

While most age groups showed a positive relationship between IS and modern contraceptive use, the 15-19 age group which the YFHS program targets, showed a negative relationship. Bivariate logistic regression confirmed that this negative relationship was statistically significant. This finding, that service environment has little impact on the youngest populations, is consistent with

other studies that explored this. These studies point to demographic traits and cultural norms (such as a young marriage age) being more responsible for improving mCPR.[163,166,209] Additionally, youth may use pharmacies, shops, and informal outlets rather than the formal health system to obtain their contraceptive methods, especially when a popular method among the youth in Malawi are male condoms. The other group that the YFHS programs targets, 20 to 24-year-olds, are more likely to be married and thus, more likely to regularly use and access modern contraceptives from the formal health system that IS measures.

Another unique aspect of this study is its use of the indirect linking method to make maximum use of the data available in the 2017 Malawi ISA. Previous literature, such as Skiles et al, has explored many different methods that can link service environment and population estimate data. These can include administrative borders, Euclidean buffer link, nearest facility, and kernel density estimation.[201] We chose this linking method after the Peters study explored different options for linking the 2017 ISA and the 2015 DHS in Malawi and recommended the most accurate method based on the nature of these data sources and after validation.[199] The method allowed this study to analyze linkages at the CA level and among individual women, rather than aggregated up to the facility or district. These results could be used by national, district, or even facility leadership to understand why there is lower IS in these areas and prioritize for improvement, especially in a context like Malawi where resources are limited.

Limitations and future research

This study was limited by the data sources available for this study. The temporality assumption was not met to prove causality because the 2015 Malawi DHS and the 2017 Malawi ISA were

used. The assumption is that FP outcomes did not change dramatically from the time the DHS was collected to when the IS data were collected. Thus, if IS became stronger since the DHS data were collected, then the association may be underestimated because the effects haven't been measured yet. Still, IS measured in 2017 could reflect the implementation of programs from a number of years before, thus being near to the time of DHS data collection. Moreover, the cross-sectional nature of both the ISA and DHS datasets and the lack of counterfactual does not allow for statements about causation. In truth, any associations between IS and modern contraceptive use does not prove causality since this study does not employ an experimental design, but an adequacy one. However, inferences from this could provide suggestions about correlation or causal relationships between IS and FP outcomes that future studies could explore in a more rigorously experimental way.

The 2008 Malawi census was used to generate HW density. Therefore, even in a country with a recognized health worker shortage for several years, density is likely overestimated.[52] We recommend recalculating HW density when the 2018 Malawi census is released. NGO facilities were not included in this analysis because we did not have access to their CA populations to calculate HW density. We were limited to MoH and CHAM facilities, thought they actually comprise nearly 90% of all facilities in Malawi. Still, Jayachandran et al (2016) found that NGOs have higher quality of care than government ones in Malawi and this could have a differential impact on youth populations.[166] Future studies could target the association between the IS at NGO facilities and key FP outcomes.

The positive relationship demonstrated between IS and modern contraceptive use needs to be understood while recognizing these issues. Ideally, we would want to measure potential FP outcomes several years after a program has started being delivered, rather than the opposite that we had. We would want these programs to have time to have an effect on the women on their catchment areas, as we do not think this effect is instantaneous. We suggest that this analysis should be done again when the 2018 Census and the 2020 DHS in Malawi are released.

An issue stemming from the ISA is that it did not measure the IS of one specific FP program, but the dose delivered across many different FP programs. There are a variety of programs being implemented across Malawi and they are each in a different stage of implementation. In other words, the exposure period of the target population to the FP programs is not uniform. This makes it difficult to attribute any change in FP outcomes to the strength of implementation to any one program. It also could wash out the effects of IS on key outcomes. Still, this is not the purpose of the study. Rather, the study aims to identify the combined effect of Malawi's FP strategy and its association with modern contraceptive use, not specific programs. There is precedent for this type of IS study that focuses on these types of outputs rather than a single program or intervention.[44]

The linking method assumes that rural women use the nearest facility; that the overlap between the facility catchment area and DHS cluster buffer accurately captures health seeking behavior. This study proceeded with this assumption following the strong results of the validation conducted by Peters et al, of this indirect linking method. Still, a direct linking method that interviews women who actually visited the facility, such as facility exit interciews, would be a

more reliable method.

Future research could explore the connection between the structural indicators of the ISA and more process-oriented indicators that likely lie between IS and modern contraceptive use. Measuring provider-client interactions could shed light on how much IS of FP programs affects the experiences of clients on the ground. Along this chain, it would also be interesting to look at the link between IS, modern contraceptive use, and fertility rates. While mCPR has been increasing consistently in Malawi over the last few decades, the total fertility rate (TFR) has stagnated recently.[55] There is likely a number of reasons for this, including the high use of short-term methods, early age of marriage and first birth.[210] Future research is needed to explore how IS has an effect down the causal pathway, especially with datasets that are more suited temporally.

Conclusions

The results of this study suggest that stronger implementation of FP programs leads to higher odds of rural women using modern contraceptives. While there are caveats about proving causality, these findings imply that the FP programs being implemented by the Malawi government have had a positive impact on rural women across the country. Still, a different approach may be needed when targeting younger women for their contraceptive needs. Leadership at the facility, district, and national level can use these results to inform future programmatic and policy decisions, especially in regards to choosing priority areas geographically and demographically. Moreover, the findings reinforce the idea that in order to limit population growth in low-resource settings and potentially reach the demographic dividend,

it is not only important to strongly implement a variety of FP programs, but to also have a high density of community health workers who provide popular contraceptive methods to rural women.

Chapter 7: Conclusions

The overall objective for this research was to develop and test a tool that rapidly assesses how strongly family planning programs are being implemented across a health system. This research explored how such an ISA could be applied in a low income country like Malawi, how data could be rapidly collected for it through mobile phone interviews, what could be analyzed based on the data collected, and whether implementation strength of these programs is associated with key FP outcomes. This research represents the first application of an ISA for family planning programs and the first to demonstrate a link between IS and modern contraceptive use. While quality of care studies have conducted similar experiments with mixed results, the key difference is that the ISA explores this idea through a programmatic, practical lens rather than a more general, theoretical concept of quality. Still, the conceptual framework for the ISA and the ensuing the domains and indicators draw heavily from this substantial research into structural and process quality in family planning. Ultimately, this research expands the way researchers and practitioners can evaluate family planning programs and their link to intended FP targets.

Summary of Results

The first aim of this research was to test the validity and feasibility of collecting data for an ISA of FP programs using mobile phone interviews with health workers across the Malawi health system. The primary objective of an ISA is to rapidly provide practitioners with an update on

how much of their program is actually being delivered on the ground. One key barrier to how fast this can be done is the traditional method of collecting data: having data collectors visit each service delivery point (SDP) within their sample in person. This study tested whether calling and interviewing these SDPs on their mobile phones adversely affected the validity of the data collected. In addition, this study tested what practically needs to be done to conduct these mobile phone interviews and whether it is more feasible than the traditional, in-person method.

We found that mobile phone interviews to collect ISA data could feasibly be done with health workers at every level of the health system in Malawi. It is important to emphasize that even the lowest level of outreach workers were able to be reached by mobile phone. While other studies have explored collecting data from the population via mobile phone interviews, this study demonstrates that collecting this type of data from health workers even in a low-income setting like Malawi is feasible. There is formative work that needs to be done to understand the context's network coverage and collect the phone numbers of the In-Charges for each health facility; in Malawi, the MoH had recently conducted such a census. This study also found that collecting data via mobile phone interviews was less than half the cost of collecting the same data via the traditional, in-person method; the main reason was transportation-related costs.

In regards to validity, we found that the majority of ISA indicators were above the threshold for sensitivity, but there were more issues with specificity. Lower specificity largely stemmed from the overuse and lack of explanation of technical terms, study design issues with the gold standard employed, and desirability bias from interviewing workers on the phone. These findings suggest that while validity was above the threshold for most indicators. data collectors should be aware

of these risks and make adjustments to how this data is collected based on this study's findings. Moreover, future validation studies should also be careful in choosing the gold standard for their indicators.

After data is collected for an ISA, most practitioners would likely focus on the quantity delivered for individual IS indicators. This would give them details of the implementation strength of individual interventions and allow for immediate targeting for improvements. Another path is to understand the combined impact of a set of FP interventions, as they are not implemented or received by the target population in isolation from one another. Moreover, the delivery points for FP in a setting like Malawi are also not unidimensional. Thus, the second aim of this research was to explore different ways to summarize implementation strength across indicators and health system levels to ultimately construct an index. This study explored four methods to combine IS data across domains and indicators, and two methods to combine data across health system levels (facility and CHW). One of the objectives of this study was to provide a step-by-step guide in how to construct an IS index using these methods. The other major objective was to compare how well each of these methods capture variation of the data, how discriminatory their score assignments are, and how well they predict couple-years protection.

There was little difference between the four methods used to combine data across indicators and domains, but major differences between the two methods used to combine data across health system levels. After reviewing the pros and cons of each method, this study recommended the PCA method to combine across indicators and the mixed effects model to combine across health system levels. Still, these recommendations are contingent on the technical capacity of the

practitioner or researcher, as well as the interpretability of the results to the intended audience. The ultimate use of such a summary measure is to understand the combined impact of a set of FP interventions, identify patterns in IS across CAs and districts, and assist with targeting priority areas for future implementation. It can be used as a policy or program planning tool that can be done repeatedly to assess progress of a national or subnational strategic plan and/or how changing outcomes could be affected by continued implementation of programs across the health system.

Once such an index is constructed for implementation strength, the natural next step is to test the association between this summary measure and key outcomes these programs are trying to influence. The hypothesis being that in areas where implementation of FP programs is stronger, there will be more women in those areas using modern contraceptives. This study was the first application of a linking method between women in DHS enumeration areas and health facility catchment areas (from the ISA) within buffers around those EAs. This study found that a higher dose of FP program implementation across the health system leads to higher odds of rural women in Malawi using modern contraceptives, even after adjusting for common predictors of modern contraceptive use like age and education. There was significant heterogeneity in the link between IS and modern contraceptive use across covariates like districts that should be explored further.

While similar studies testing the link between FP quality and mCPR are mixed, this study finds a fairly strong association. While the ISA focuses more on implementation of programs rather than general concept of quality, it contributes to the evidence base that increasing quality or IS

leads to better outcomes. These results also give criterion validity to the IS indicators and the summary measure created from them. The larger contribution that these results suggest is that stronger implementation of these programs leads to an increase in the impact these programs are intending to have. This type of result can help policymakers make the case for further investment and emphasis on large-scale FP programs. Thus, program managers should focus on ensuring that these programs are delivering the maximum quantity and can test for this using the ISA tool this research has developed.

Limitations

One of the major limitations found from the validation study was using the records and observations of health workers as the gold standard to test for sensitivity and specificity. These records themselves are prone to error. We also found that these records were often not complete across every health facility and village clinic in the sample in Malawi, and thus did not allow for a comparator to the phone responses.

There were also issues around recall bias and desirability bias among health providers. We tried to address this by emphasizing that health workers have their records in front of them during the phone interview and consult them when answering questions rather than relying on memory. On the other end, there could have been interviewer bias, where some interviewers ask or clarify survey questions more clearly. While the supervisors of each team were trained to monitor this, the relative simplicity of this quantitative survey also argues against such bias having a substantial effect.

There can be problems that arise from the ISA in Malawi that did not measure the IS of one specific FP program, but the dose delivered across many different FP programs. There were a variety of programs being implemented across the country and they likely were each in a different stage of implementation. This makes it difficult to attribute any change in FP outcomes to the strength of implementation to any one program. Still, this is not the purpose of the study. Rather, the study aims to construct a multifaceted representation of IS and test its combined effect with key FP outcomes. It does not aim to evaluate specific FP programs and their individual association with FP outcomes. A related issue is that the findings are fairly context-specific to Malawi due to the nature of index creation and the focus on FP programs. However, much consideration was given during the construction of the conceptual framework and the ensuing indicators to ensure these were global measures of FP program implementation and not specific to what was being implemented in Malawi specifically.

The cross-sectional study design of this research is also challenging and does not allow for causal inference. Still, the major purpose of the study is to explore the findings from an ISA and potential associations with FP outcomes. Any links found between IS and key FP outcomes were not to be interpreted as causal, but rather suggesting that a possible association could be present. Along the same lines, another issue is that the ISA collected data (in July 2017) at a different point in time than when data for FP outcomes has been collected in the 2015-16 DHS. Thus, the IS of FP programs may have been different at the time DHS data were collected than when we collect data about them (i.e. relevant exposure window). The assumption made here is that FP outcomes did not change dramatically from the time the DHS was collected to when the IS data will be collected. Still, inferences from this could provide suggestions about correlation

or causal relationships between IS and FP outcomes that future studies could explore in more depth.

Policy and Practice Implications

There has been overwhelmingly strong evidence through research and practice over the past several decades that family planning interventions and programs work. This has been increasingly evident for FP programs targeting the youth. A critical question still remains around how strongly these evidence-based FP programs are being implemented in real world contexts.

Policymakers and practitioners want to know the implementation strength of different programs so they can prioritize their investments accordingly and make decisions based on real-time evidence. Implementers, from government to development partners, need to know how strongly their FP program is being implemented during the life of their program in order to make the necessary adjustments and achieve maximum impact. Evaluators want additional evidence, even in the absence of a counterfactual, to suggest whether the programs were implemented well and if they are linked to changes in intended outcomes and impact. Moreover, data collected from routine, existing systems are often of low quality and completeness.

This research aimed to address this gap in knowledge and feasibility. The indicators for this cross-sectional survey were carefully compiled through a rigorous literature review and consultation with a set of experts. This research found that collecting data for these indicators using mobile phone interviews is both cost-effective and valid, which give practitioners a more efficient and inexpensive way of collecting primary data for the ISA. This allows for more

immediate reports and dissemination materials that can inform data-driven decision-making, as well as repeated application of the tool to check implementation progress.[120]

The government of Malawi recently prioritized youth FP and is in the process of operationalizing its "Costed Implementation Plan for Family Planning."[49] However, challenges remain about how strongly actors (especially non-governmental ones such as donors and NGOs) have been implementing and to what effect. The results of this ISA can help inform this government of the implementation strength of FP programs at every health facility and district in the country. Policymakers and practitioners in Malawi can use this ISA to understand the coverage of health workers providing FP by cadre and what interventions are being implemented the most strongly by these providers. This research also provides practitioners with several options for summarizing this IS data into an index in order to better understand the comprehensive impact of the implementation of their FP policies and programs on the FP outcomes they aim to improve.

This type of information can inform a range of practical and policy considerations at the national, district, and community level. For instance, health authorities and program managers can identify districts where IS seems to be weaker or even where the association between IS and modern contraceptive use is not as positive as other areas. They can then use this information to dig deeper about the reasons for these results, and even go lower to the catchment area level to look for key contributors. One potential application that could be explored in the future would be to look at what specific indicators were most associated with key FP outcomes and prioritize these in targeted areas. This information could also be used to increase the understanding, transparency and accountability of these FP programs to key health system stakeholders and the

population. In addition, planners and policymakers can use the summary measure method to find the best mix of FP interventions that seem to have the strongest effect on intended outcomes. Repeated application of this type of ISA can give the government a routine source of data about the quantity of FP delivered and can inform how policies and programs for FP are adjusted in the future.

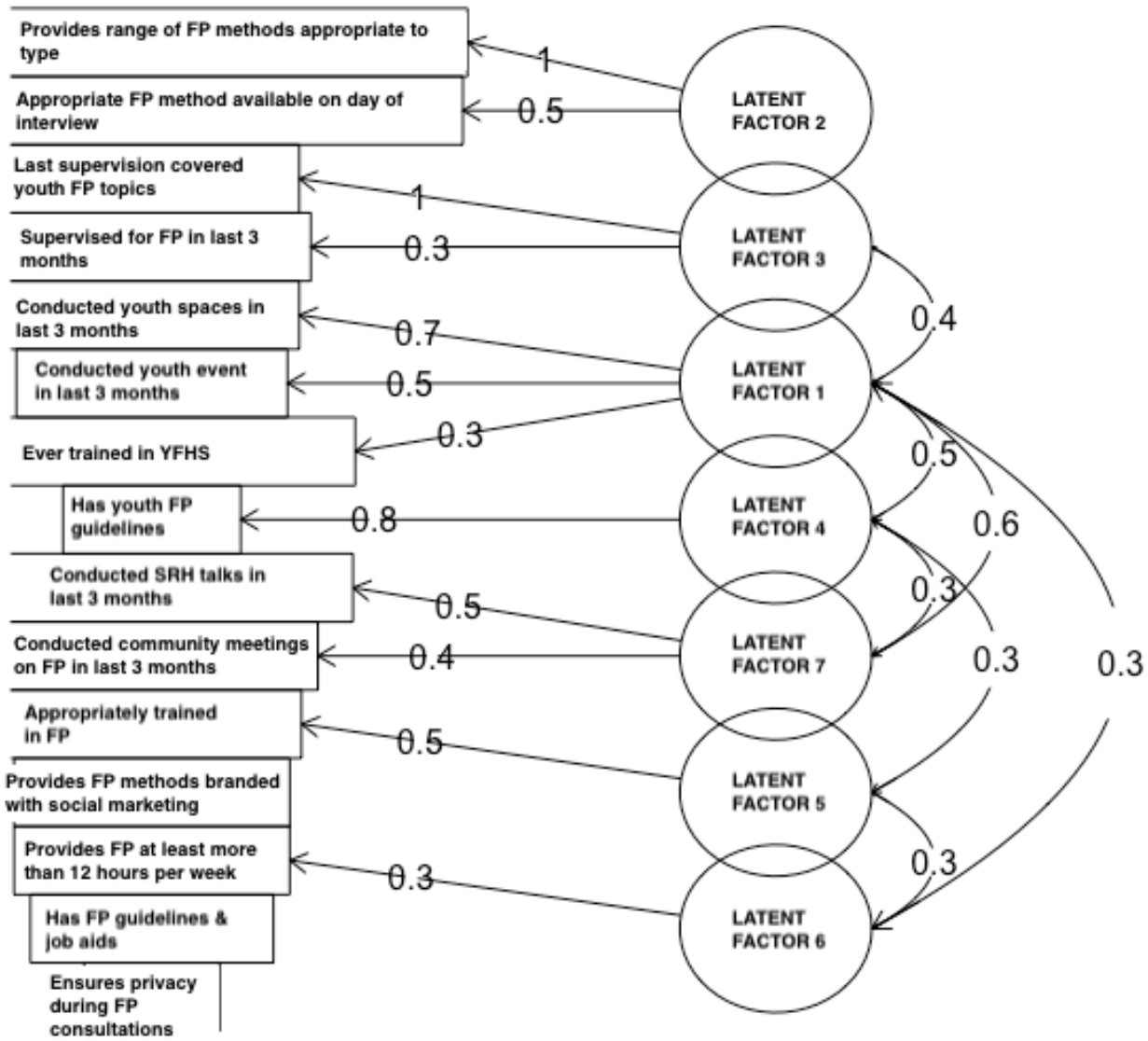
This research also can have implications beyond Malawi. The results of this first application of the ISA in Malawi can be used to improve the tool itself for later application in other contexts. The ISA can also be trimmed to match the needs of a host country. For instance, it can evaluate the IS of a specific FP program on training, rather than its more broad application in Malawi. The results from Malawi also demonstrate how the tool works and what types of data it can produce. Moreover, it suggests that there is a link between increasing the strength of program implementation and higher modern contraceptive us among rural women in Malawi. This can contribute to the literature that still consists of mixed results for the association between structural quality and mCPR. Still, the generalizability of these specific results are limited due to the ISA applied in the unique context of Malawi; a low income, sub-Saharan African country with a very limited health workforce and slim fiscal envelope for health. Moreover, the threats to internal validity cascade into this study's external validity. Still, this research can provide deeper insights into what the components of implementation strength of family planning programs are, how they combine together, and how this may be tied to key intended outcomes. This research resulted in a tool that that has been applied at its widest capability (across multiple FP programs rather than just one). The ultimate result from this research is an ISA tool that can be used to rapidly assess the quantity of program delivered and the effect of that program

(individually and combined) and which has been expressly developed and tested for validity, effectiveness, and practicality for actual implementers to use throughout the life of their programs.

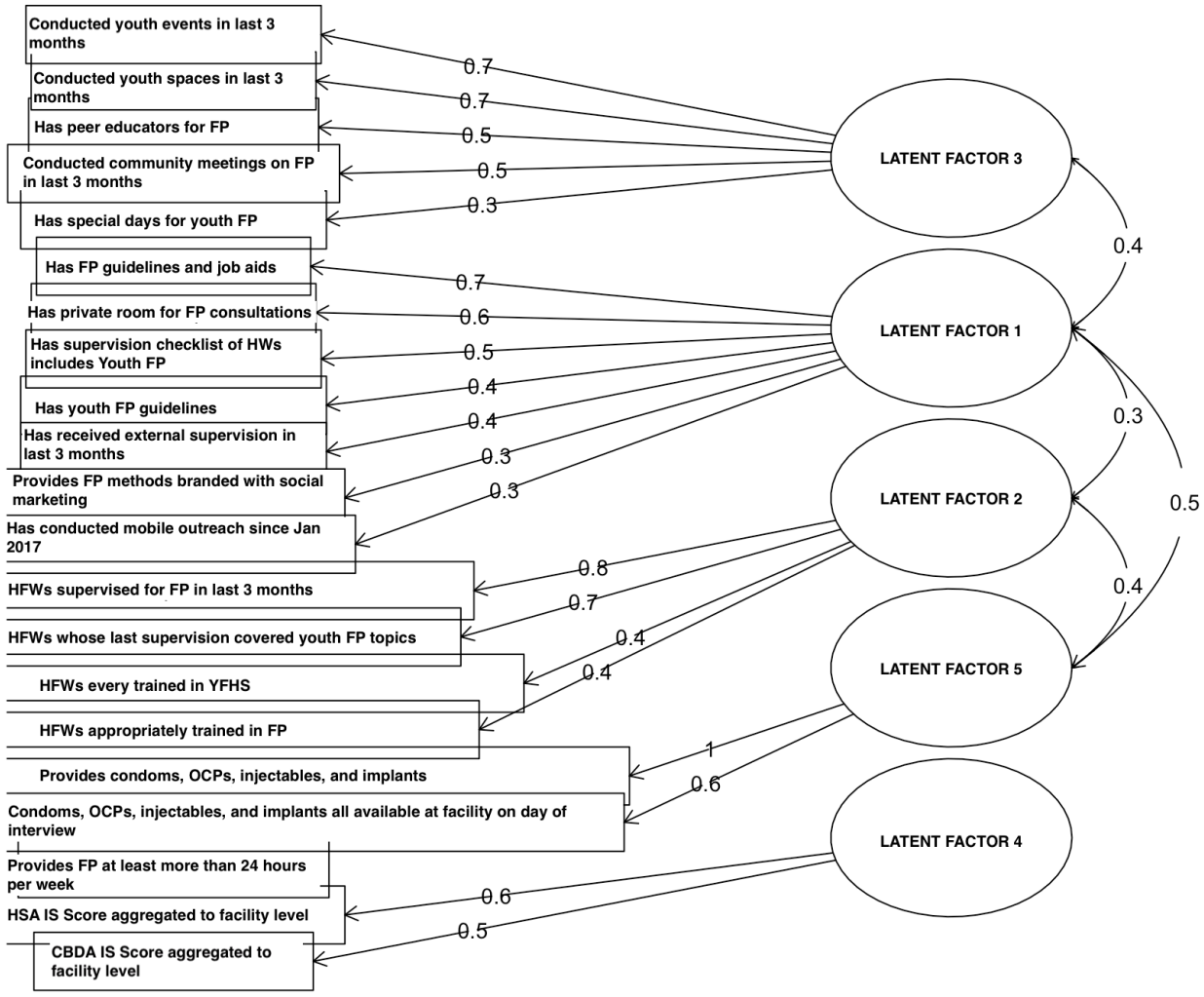
Annex:

Annex A. Supplementary Figures

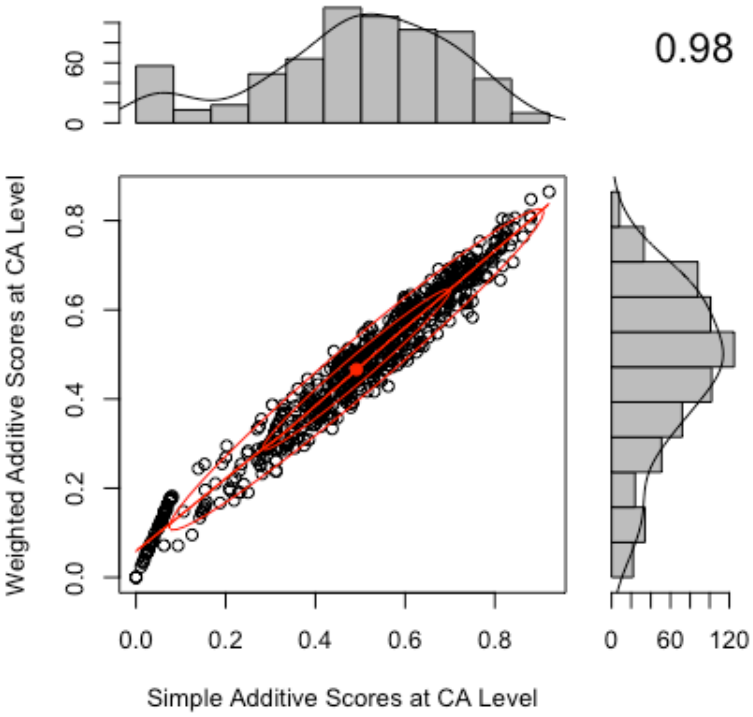
Supplementary Figure 5.1: Diagram of latent factors and indicators with factor loadings at the community health worker level



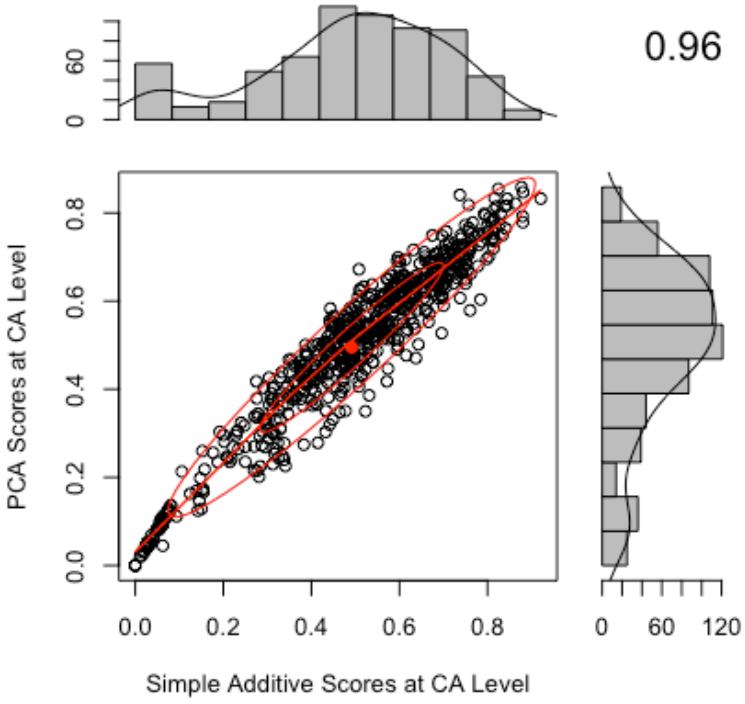
Supplementary Figure 5.2: Diagram of latent factors and indicators with factor loadings at the health facility catchment area level (using the simple average combination model)



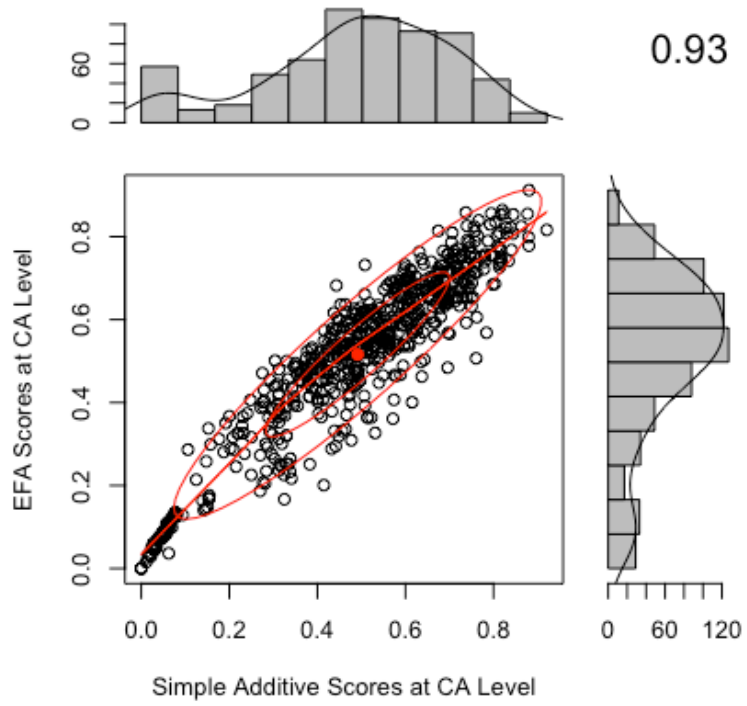
Supplementary Figure 5.3: Two-way scatterplot comparing the simple additive and weighted additive IS scores at the catchment area level that use the simple average combination model



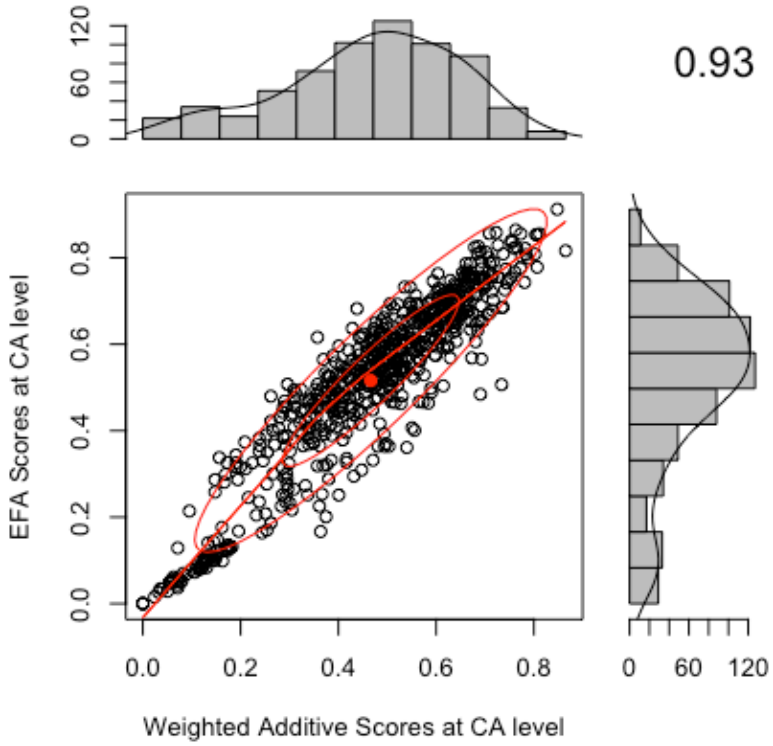
Supplementary Figure 5.4: Two-way scatterplot comparing the simple additive and PCA IS scores that use the simple average combination model



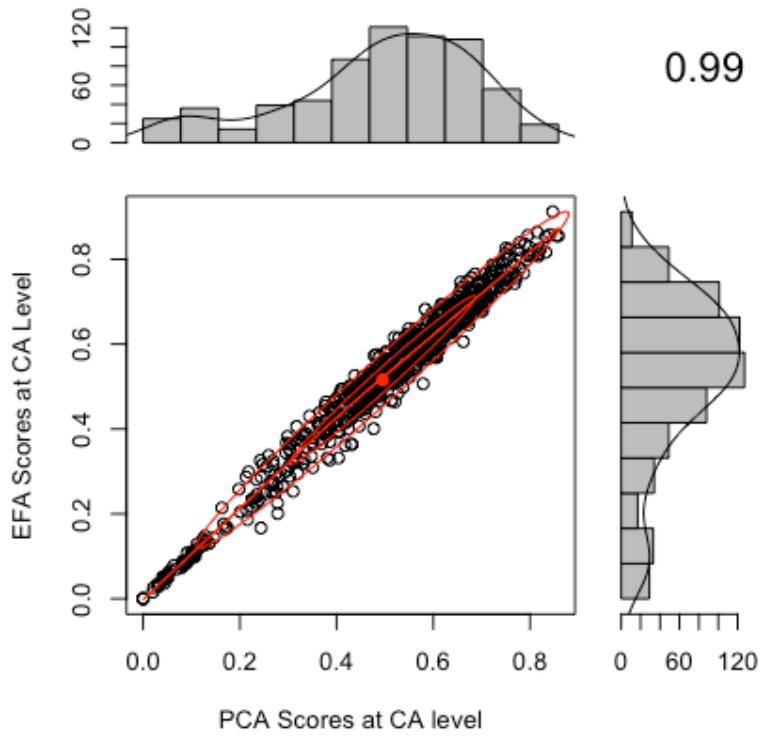
Supplementary Figure 5.5: Two-way scatterplot comparing the simple additive and EFA IS scores that use the simple average combination model



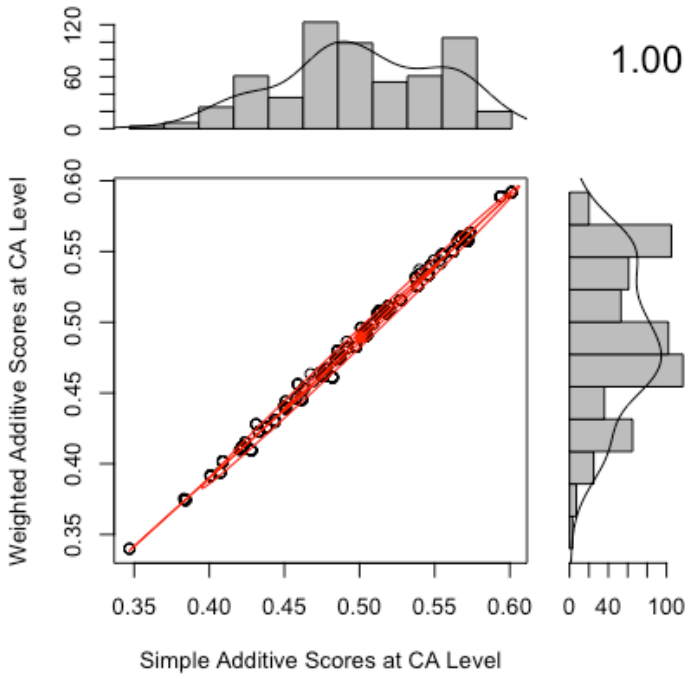
Supplementary Figure 5.6: Two-way scatterplot comparing the weighted additive and EFA IS scores that use the simple average combination model



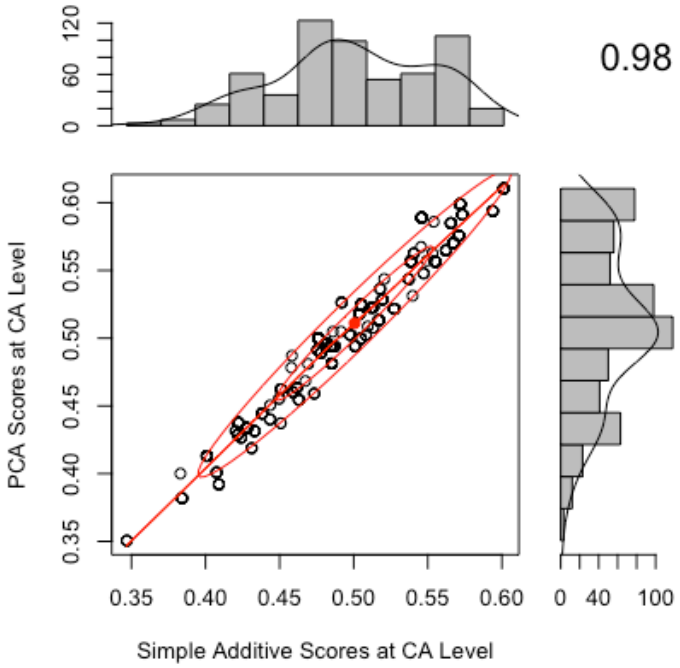
Supplementary Figure 5.7: Two-way scatterplot comparing the PCA and EFA IS scores that use the simple average combination model



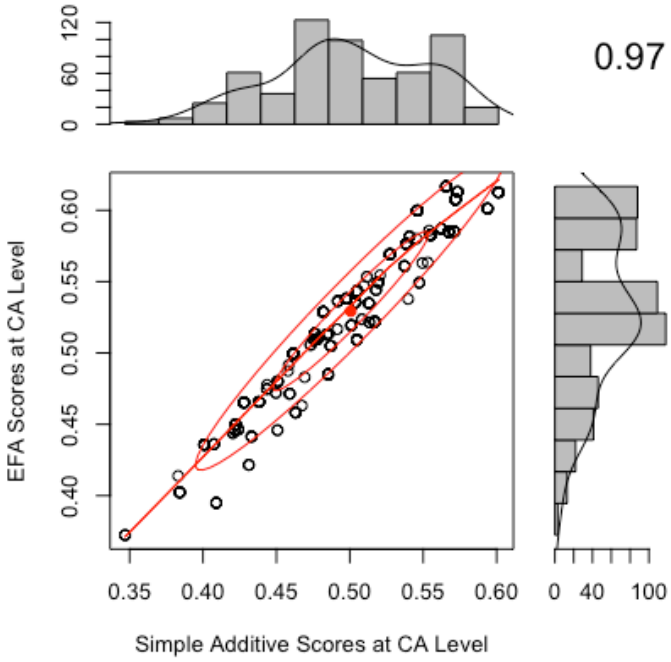
Supplementary Figure 5.8: Two-way scatterplot comparing the simple additive and weighted additive IS scores that use the mixed effects combination model



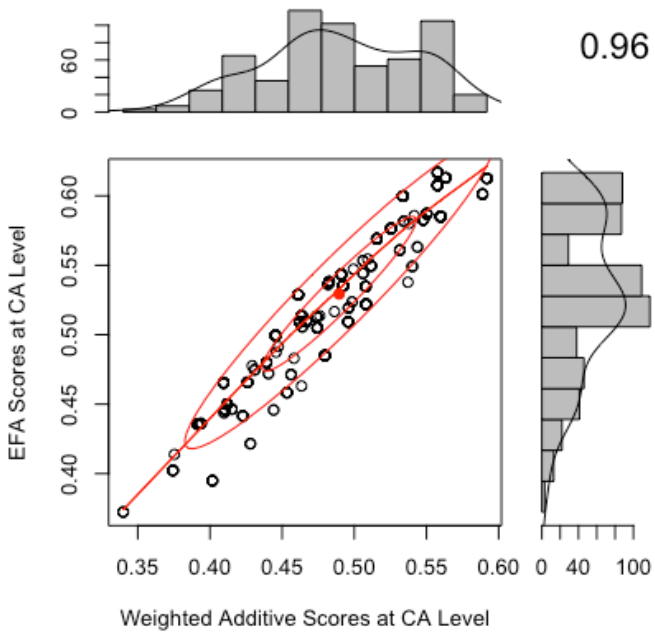
Supplementary Figure 5.9: Two-way scatterplot comparing the simple additive and PCA IS scores that use the mixed effects combination model



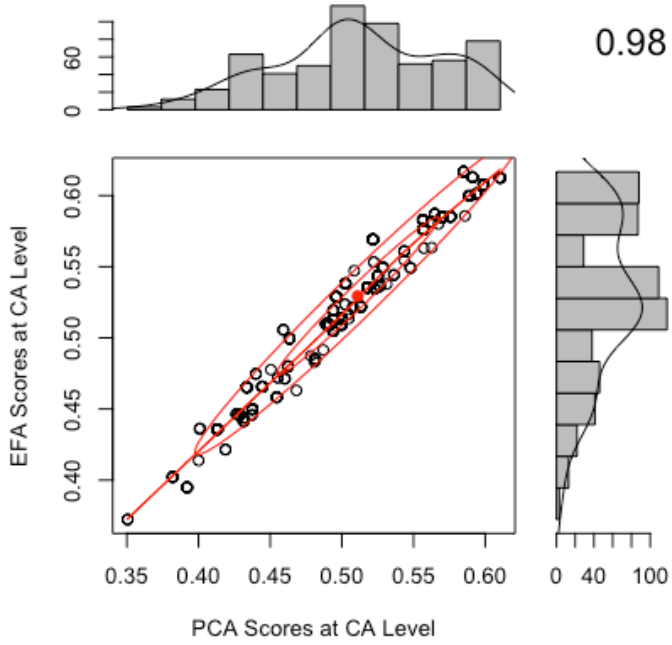
Supplementary Figure 5.10: Two-way scatterplot comparing the simple additive and EFA IS scores that use the mixed effects combination model



Supplementary Figure 5.11: Two-way scatterplot comparing the weighted additive and EFA IS scores that use the mixed effects combination model



Supplementary Figure 5.12: Two-way scatterplot comparing the PCA and EFA IS scores that use the mixed effects combination model



Annex B. Supplementary Tables

Supplementary Table 5.1: Factor loadings above threshold for principal components analysis of IS indicators at the community health worker level

Items included in PCA with factor loadings > 0.3	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Appropriately trained in FP*			0.79				
Ever trained in YFHS						0.86	
Conducted youth event in last 3 months	0.69						
Conducted SRH talks in last 3 months	0.68						
Conducted youth spaces in last 3 months	0.66					0.31	
Conducted community meetings in last 3 months	0.72						
Provides FP methods branded with social marketing			0.70				
Has youth FP guidelines						0.34	0.59
Has FP guidelines and job aids							0.81
Provides range of FP methods appropriate to type		0.84					
Appropriate FP method available on day of interview		0.87					
Ensures privacy during FP consultations							0.46
Provides FP at least more than 12 hours per week					0.94		
Supervised for FP in last 3 months				0.84			
Last supervision covered youth FP topics				0.76			
	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Eigenvalue	2.10	1.55	1.20	1.37	1.02	1.13	1.34
Proportion of variance explained	0.14	0.10	0.08	0.09	0.07	0.08	0.09
Cumulative variance explained	0.14	0.24	0.50	0.33	0.65	0.58	0.42

Supplementary Table 5.2: Factor loadings above threshold for principal components analysis of IS indicators at the health facility catchment area level (using simple average method to combine across health facility and CHW levels)

Items included in PCA with factor loadings above 0.3	PC1	PC2	PC3	PC4	PC5
Has supervision checklist of HWs includes Youth FP	0.60	0.31			
Has received supervision that included FP from someone external to the facility in previous 3 reporting months	0.51				
Has FP guidelines and job aids	0.67				
Has youth FP guidelines	0.56				

Provides FP methods branded with social marketing	0.54				
Provides condoms, OCPs, injectables, and implants					0.79
Condoms, OCPs, injectables, and implants all available at facility on day of interview					0.82
Provides FP at least more than 24 hours per week					0.52
Has conducted mobile outreach since Jan 2017	0.47				
Has private room for FP consultations	0.64				
Has special days for youth FP		0.48			
Conducted youth event in last 3 months		0.76			
Conducted community meetings in last 3 months		0.62			
Conducted youth spaces in last 3 months		0.76			
Has peer educators for FP		0.67			
HFWs appropriately trained in FP				0.61	
HFWs Ever trained in YFHS				0.62	
HFWs supervised for FP in last 3 months				0.79	
HFWs whose last supervision covered youth FP topics				0.78	
CBDA IS Score aggregated to facility level			0.87		
HSA IS Score aggregated to facility level			0.75		
	PC1	PC2	PC3	PC4	PC5
Eigenvalue	3.63	3.56	3.26	2.81	2.42
Proportion of variance explained	0.14	0.14	0.13	0.11	0.09
Cumulative proportion of variance explained	0.14	0.28	40.00	51.00	60.00

Annex C. Data Collection Tools

C1. Health Center In-Charge Survey Instrument

Form 2. Mobile Interview of HW Questionnaire		
1A	**ADMINISTRATION**	
1A1.	Interviewer name	
1A2.	Date of interview	
1A3.	District name	Can assign zone during analysis phase
1A4.	District code	NSO has standard district codes
1A5.	Name of Health facility	
1A6.	Affiliation of the facility	(1) Government (MOH/LG)

	they are associated with (get their materials from):	(2) CHAM (3) NGO: (specify:) (8) Other		
1A7.	Type of facility:	(1) Central Hospital (2) District Hospital (3) Health Centre (4) Health Post (8) other (specify):		
1A8.	Locality of Community they work out of:	(1) Rural (2) Urban (3) Peri-urban		
1A9.	First and Last Name of In-Charge	First Name _____ Last Name _____		
1A10.	In-Charge Telephone Number			
1A11.	Call Attempt 1	Call Attempt 2	Call Attempt 3	Call Attempt 4
1A12.	Date:	Date:	Date:	Date:
1A13.	Time:	Time:	Time:	Time:
1A14.	Result code:	Result code:	Result code:	Result code:
1A15.	Call Attempt 5	Call Attempt 6	Call Attempt 7	Call Attempt 8
1A16.	Date:	Date:	Date:	Date:
1A17.	Time: :	Time:	Time:	Time:
1A18.	Result code:	Result code:	Result code:	Result code:
1A19.	Result Codes: 1= Completed, 2= Rescheduled call, 3 = Ring but no answer, 4= "cannot be reached" or out-of-network, 5 = Busy signal or "on other line", 6= "wrong number" or "does not exist"; 7=No mobile phone, 9 = Other			
1A20.	Special Arrangements/Reschedule Plan:			
1A21.	Time interview begun	__ __ h __ __ min		
1A22.	[Read brief script about who we are and then ask] Does your health facility provide any family planning services?			(1) Yes (2) No →

			END
1A23.	If yes, read the informed consent script to the HP. Does the Health Facility In-Charge give their consent for this interview?		(1) Yes (2) No → **END**
1A24.	Type of occupation..	(1) Doctor (MBBS) (2) Clinical Officer (3) Medical Assistant (4) Nurse/Midwife (5) Other _____	
1A25.	What year did you start working as an in-Charge at this facility?	Year _ _ _ _	
1B	**Contact Information for Health Workers associated with Health Facility** Now I want to ask you about all the health workers who work in your facility that routinely provide family planning services. We want to interview these health workers on the phone to understand their training, supervision, and provision of family planning services to their communities. We will not contact them for any other reason except for their interview and their identities or contact information will not be shared with anyone else. All the data collected from these workers will only be used to understand how family planning services are being provided in Malawi.		
1B-01.	Name	Position	Phone number
1B-02.			
1B-03.			
1B-04.			
1B-05.			
1B-06.			
1B-07.	Does this facility provide family planning support, supplies, or supervision to Health Surveillance Agents and Community-Based Distribution Agents (CBDAs)?		(1) Yes (2) No (99) DK
	If yes, please ask the In-Charge for the names, positions, and phone numbers of these community-based workers		
1B-08.	Name	Position	Phone number
1B-09.			
1B-10.			
1B-11.			
1B-12.			
1B-13.			

1B-14.			
1C	**ACCESSIBILITY OF FP SERVICES TO YOUTH** Now I want to ask you about when and how you provide family planning services at your health facility		
1C-01.	What year did this facility first begin offering family planning services / products?	MM/YY: _ _ / _ _ (99) Don't know	
1C-02.	How many days a typical week does your health facility provide family planning services? [Enter a number between 0 and 7. Enter 0 for less than 1 day per month. Enter -88 for do not know, - 99 for no response]	Number of days: _____	
1C-03.	On the days your health facility provides FP services, how many hours on average is FP provided? [Enter a number between 0 and 24. Enter -88 for do not know, - 99 for no response]	Number of hours: _____	
1C-04.	On the days you provide FP services, what part of the day do you usually provide?	(1) Morning (9-12) (2) Afternoon (12-4) (3) Evening (4-7)	
1C-05.	Does your health facility have any special days where you provide FP for youth?	(1) Yes (2) No (99) DK	
1C-06.	If yes, how often does your health facility have these special days for youth FP?	(1) Once a week (2) Once every two weeks (3) Once every month (4) Once every 2 months (5) Once every 6 months (6) (99) DK	
1C-07.	Is your health facility accredited as providing youth-friendly health	(1) Yes (2) No (99) DK	

	services?	
1C-08.	If yes, when was it accredited?	M M / Y Y
1C-09.	Is there a mobile outreach team that works out of your facility?	(1) Yes (2) No (99) DK
1C-10.	[If yes to 1B-07] How frequently do these mobile outreach clinics occur?	(1) Once a week (2) Once every two weeks (3) Once every month (4) Once every 3 months (5) Once every 6 months ago (6) Once a year
1C-11.	[If yes to 1B-07] what types of family planning methods does this mobile outreach provide? Select one response	(1) Condoms (2) Oral contraceptive pills (3) Injectables (4) Implants (5) Other: _____
1C-12.	If a client comes in looking for a FP method and your facility does not have it at the moment, do you provide a referral to another facility?	(1) Yes (2) No (99) DK
1C-13.	If yes, what is the name of the facility?	
1C-14.	Does your health facility provide HIV prevention and treatment services?	(1) Yes (2) No (99) DK
1C-15.	[If yes] are these HIV services integrated with family planning services at your health facility?	(1) Yes (2) No (99) DK
1D	**PROVIDER TRAINING** Now I want to ask you about some general training questions for all the health workers you listed above	
1D-01.	[Ask for each health worker listed] have they ever been trained to provide family planning services?	(1) Yes (2) No (99) DK
1D-02.	[Ask for each health worker listed] have they ever been trained to provide youth-friendly health services	(1) Yes (2) No (99) DK
1E	**Availability and Provision of Contraceptive Methods, Supplies, and Equipment** Now I want to ask you about some questions about the contraceptive methods your health facility provides	
1E-01.	Does your health facility have	(1) Yes (2) No (99) DK

	any guidelines or protocols for health workers to use to provide family planning?				
1E-02.	Does your health facility have any guidelines or protocols for health workers to provide family planning specifically to youth?	(1) Yes (2) No (99) DK			
1E-03.	Does your health facility provide family planning services that are designed to be youth or adolescent friendly? (i.e. designed with the specific aim to encourage youth or adolescent utilization?)	(1) Yes (2) No (99) DK			
1E-04.	Does your health facility have posters and pamphlets for family planning?	(1) Yes (2) No (99) DK			
1E-05.	Does your health facility have job aids for health workers to use when delivering family planning services?	(1) Yes (2) No (99) DK			
1E-06.	Does your health facility have a space that provides audio and visual privacy for family planning consultations?	(1) Yes (2) No (99) DK			
1E-07.	Does your health facility have a room designated only for youth activities?	(1) Yes (2) No (99) DK			
1E-08.	I now want to ask you about the types of family planning methods your health facility provides and how available they have been recently [Go through each FP method below from left to right. For example, first ask if they provide male condoms. If yes, ask if it is available today. Then ask if they have experienced a stockout for male condoms since December 1st, 2016. If the answer is yes, ask them how many days the stockout lasted for. If the answer is no, then move directly to when this current stockout started. Once all the questions from left to right are finished for male condoms, move on to the next method and start the process again]				
1E-09.	1. Type of Contraceptive	2. Does your HF provide	3. Is it available Today	4. Has there been a stockout of	5. [If yes] how many

	Method	this Method to Youth?		X method since Jan 1st, 2017?	days did the stockout last?
1E-10.	A. Male Condoms	(1) Yes (2) No	(1) Yes (2) No	(1) Yes (2) No	
1E-11.	B. Oral Pills	(1) Yes (2) No	(1) Yes (2) No	(1) Yes (2) No	
1E-12.	C. Injectables	(1) Yes (2) No	(1) Yes (2) No	(1) Yes (2) No	
1E-13.	D. Implants	(1) Yes (2) No	(1) Yes (2) No	(1) Yes (2) No	
1E-14.	E. IUDs	(1) Yes (2) No	(1) Yes (2) No	(1) Yes (2) No	

1E-15.	From family planning register, please tell me: (1) The total number of family planning visits (new and continuing) in the **last 7 days**, for each method. (2) The number of new clients who received family planning services in the last completed month, for each method. Past completed month. (3) The number of clients who were between the age of 15 to 19 (4) The number of clients who were between the age of 20 to 24 Enter -88 for do not know, enter -99 for no response.	
1E-16.	Do any NGOs provide contraceptive methods at your facility on a regular basis?	(1) Yes (2) No (99) DK
1E-17.	[If yes] what methods do	

	# of visits	# new clients	# of women 15-19	# of women 20-24
Implants				
IUD				
Injectables-3 month				
Injectables-1 month				
Pill				
Male Condom				

	they provide?	
1E-18.	[If yes} how frequently do they provide this method(s) at your facility?	
1F	**DEMAND GENERATION & BEHAVIOR CHANGE** Now I want to talk to you about any activities that your health facility has been involved with that aim to increase the knowledge and change the behavior of people in your community about sexual and reproductive health and contraceptive methods	
1F-01.	In the last 3 months, has your health facility participated in events with youth in your community that aims to increase their knowledge and skills on sexual and reproductive health and family planning? These can include youth fairs, social weekends, community dramas	(1) Yes (2) No (99) DK
1F-02.	[If yes] how many events did you participate in the last 3 months?	_____ _____
1F-03.	In the last 3 months, has your health facility participated in any meetings with parents, village chiefs, or religious leaders in your community, specifically about increasing knowledge and utilization of family planning methods?	(1) Yes (2) No (99) DK
1F-04.	[If yes] how many meetings did you participate in the last 3 months?	_____ _____
1F-05.	In the last 3 months, has your health facility participated in any alternative spaces that aim to provide information and build skills among youth for family planning? For example, youth clubs, youth centres, non-formal education settings where youth meet	(1) Yes (2) No (99) DK
1F-06.	[If yes] how many youth spaces did you participate in the last 3 months?	_____ _____
1F-07.	In the last 3 months, has your health facility participated in any hotlines, social media, radio, or mobile technology programs that are set up for youth to receive information, and answer questions on sexual and reproductive health and family planning?	(1) Yes (2) No (99) DK
1F-08.	In the last 3 months, has your health facility worked with interpersonal agents, reproductive health	(1) Yes (2) No

	agents (RHAs), peer educators, or youth CBDAs to provide FP to youth?	(99) DK
1F-09.	If yes, which type of worker did your facility have?	(1) Interpersonal agents (2) Reproductive health agents (3) Peer educators (4) Youth CBDAs
1F-10.	If yes, how many workers of this type are currently working with your facility?	
1G	**SUPERVISION** Now I want to ask you some questions about the supervision you have personally received for the family planning services you provide	
1G-01.	When was the last time a supervisor from outside this facility came here to visit?	(1) Never external supervision (2) Within the past 6 months (3) More than 6 months ago (4) Don't Know (5) No response
1G-02.	Do health workers at your facility who provide family planning services receive regular supervision from someone inside your facility?	(1) Yes (2) No (99) DK
1G-03.	Do health workers associated with your facility who provide family planning services in the community (HSAs and CBDAs) receive regular supervision from someone inside your facility?	(1) Yes (2) No (99) DK
1G-04.	[If yes] are these supervisions supposed to review anything specific to family planning provision to youth clients?	(1) Yes (2) No (99) DK
1G-05.	Are health workers supervised at your facility on Youth-friendly Health Services (YFHS) specifically?	(1) Yes (2) No (99) DK

Thank the respondent and ask them if they have any last questions.

C2. Health Facility Worker Survey Instrument

Form 2. Mobile Interview of HFW Questionnaire		
2A	**ADMINISTRATION**	
2A-01.	Interviewer name	
2A-02.	Date of interview	

2A-03.	District name	Can assign zone during analysis phase		
2A-04.	District code	NSO has standard district codes		
2A-05.	Name of Health facility			
2A-06.	Affiliation of the facility they are associated with (get their materials from):	(1) Government (MOH/LG) (2) CHAM (3) NGO: (specify:) (8) Other		
2A-07.	Type of facility:	(1) Central Hospital (2) District Hospital (3) Health Centre (4) Health Post (8) other (specify):		
2A-08.	Locality of Community they work out of:	(1) Rural (2) Urban (3) Peri-urban		
2A-09.	Type of Health Worker	(1) Health Facility Worker (2) Health Surveillance Agent (HSA) (3) Community-Based Distribution Agent (CBDA)		
2A-10.	First and Last Name of Health Worker	First Name _____ Last Name _____		
2A-11.	HW Telephone Number			
2A-12.	Call Attempt 1	Call Attempt 2	Call Attempt 3	Call Attempt 4
2A-13.	Date:	Date:	Date:	Date:
2A-14.	Time:	Time:	Time:	Time:
2A-15.	Result code:	Result code:	Result code:	Result code:
2A-16.	Call Attempt 5	Call Attempt 6	Call Attempt 7	Call Attempt 8
2A-17.	Date:	Date:	Date:	Date:
2A-18.	Time: :	Time:	Time:	Time:
2A-19.	Result code:	Result code:	Result code:	Result code:

	Result Codes: 1= Completed, 2= Rescheduled call, 3 = Ring but no answer, 4= "cannot be reached" or out-of-network, 5 = Busy signal or "on other line", 6= "wrong number" or "does not exist"; 7=No mobile phone, 9 = Other	
2A-20.	Special Arrangements/Reschedule Plan:	
2A-21.	Time interview begun	__ __ h __ __ min
2A-22.	[Read brief script about who we are and then ask] In your current position, do you personally provide any family planning services?	(1) Yes (2) No → **END**
2A-23.	If yes, read the informed consent script to the HP. Does the HP give their consent for this interview?	(1) Yes (2) No → **END**
2B	**DEMOGRAPHICS**	
	I would like to ask some questions about your personal, educational, and professional background.	
2B-01.	How old were you at your last birthday? [Record Age in completed years]	__ ___
2B-02.	Are you male or female?	(1) Male (2) Female
2B-03.	What is your religion [specify sect, if needed]	(1) Catholic (2) CCAP (3) Anglican (4) Seventh Day Adventist/Baptist (5) Other Christian (6) Muslim (7) No Religion (8) Other_____
2B-04.	What is your marital status?	(1) Married (traditional, religious, or civil marriage) (2) In a relationship, but not married (3) Separated/divorced

		(4) Widowed (5) Single (6) Other (specify) _____
2B-05.	What is the highest educational qualification you have achieved?	(1) Primary School Living Certificate (2) Secondary School Junior Certificate (3) Secondary School Malawi School Certificate of Education Examination (MSCe) (4) College Certificate (5) College Diploma (6) College Degree
2B-06.	[If HFW]: What is your current occupational category or qualification? For example, are you a registered nurse, or generalist doctor, or medical assistant?	(1) Doctor (MBBS) (2) Clinical Officer (3) Medical Assistant (4) Nurse/Midwife (5) Other _____
2B-07.	What year did you start working as this occupation?	Year _ _ _ _
2B-08.	What year did you start working in this catchment area?	Year _ _ _ _

2C	**PROVIDER TRAINING** Now I want to ask you about some questions about your training		
2C-01.	Have you ever been trained to provide family planning services?	(1) Yes (2) No→ **2C-07**	
	I now want to ask you about the types of family planning training you have received [Go through each Training type below from left to right. For example, first ask if the training they have received training included FP counseling. If yes, ask if that training occurred in since Jan 2015 (in the last two years). Then ask if they received any refresher trainings since Jan 2015]		
		Did training for _____ include:	Did training for ____ occur since Jan 2015?
2C-02.	General counseling for FP	(1) Yes	(1) Yes

		(2) No (99) DK	(2) No (99) DK
2C-03.	Providing condoms	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-04.	Provide oral contraceptive pills	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-05.	Providing injectables (e.g. Depo Provera)	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-06.	Providing implants (e.g. Jadele)	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-07.	Providing IUDs	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-08.	Have you ever been trained in providing Youth-Friendly Health Services (YFHS)?	(1) Yes (2) No→ **2D-01**	
2C-09.	[If yes] Did the YFHS training occur since January 2015?	(1) Yes (2) No (99) DK	
2C-10.	Have you ever been trained in providing HIV prevention services?	(1) Yes (2) No (99) DK	
2C-11.	[If yes] Did this HIV prevention training occur since Jan 2015?	(1) Yes (2) No (99) DK	
2D	**Availability and Provision of Contraceptive Methods, Supplies, and Equipment** Now I want to ask you about some questions about the contraceptive methods you provide		
2D-01.	As part of your work, do you provide FP or HIV prevention services that are designed to be youth or adolescent friendly? (i.e. designed with the specific aim to encourage youth or adolescent utilization?)	(1) Yes (2) No	
2D-02.	Do you have any guidelines or protocols for providing contraceptive methods?	(1) Yes (2) No	
2D-03.	Do you have any guidelines or protocols for	(1) Yes (2) No	

	providing contraceptive methods to YOUTH and adolescents?		
2D-04.	When you provide counseling to youth about family planning, what are the types of issues you usually counsel them about? (probe and record all responses)	A. Information on the range of method options available B. Potential risks and side effects of each method C. STDs, including HIV D. Reduce stigma around FP E. Where youth can access contraceptives F. Promoting abstinence G. Changing contraceptive use behavior H. Advice on when is the best time for youth to have their first baby I. Advice to those with children on when they want to have another baby (and/or whether to wait)	(1) Yes (2) No (1) Yes (2) No (1) Yes (2) No (1) Yes (2) No (1) Yes (2) No (1) Yes (2) No (1) Yes (2) No (1) Yes (2) No (1) Yes (2) No
2D-05.	When you provide contraceptive counseling or methods to youth, how often are you able to find a space where no one can SEE the interaction?		(1) Never (2) Sometimes (3) Always
2D-06.	When you provide contraceptive counseling or methods to youth, how often are you able to find a space where no one can HEAR the interaction?		(1) Never (2) Sometimes (3) Always
2D-07.	When you provide family planning or HIV prevention services to youth, what do you say to them so they feel like your conversation is confidential? (check off items) Record all responses	(1) Verbal assurance given from the start (2) Every question they have will be confidential (3) Nothing will get back to their parents (4) Other_____	
2D-08.	Do you have job aids or pamphlets that help you counsel or provide contraceptive services?		(1) Yes (2) No (99) DK
2D-09.	Do you have job aids or pamphlets that help you counsel or provide contraceptive services specific to youth?		(1) Yes (2) No (99) DK
2D-10.	In the last 3 months, have you participated in any mobile outreach clinics that provide contraceptive methods to hard-to-reach areas in your community?		(1) Yes (2) No (99) DK

2D-11.	[If yes] how many outreach clinics did you participate in the last 3 months?				_____ _____
2D-12.	I now want to ask you about the types of contraceptive methods you provide and how available they have been for you recently [Go through each contraceptive method below from left to right. For example, first ask if they provide male condoms. If yes, ask if it is available today. Then ask if they have experienced a stockout for male condoms since December 1st, 2016. If the answer is yes, ask them how many days the stockout lasted for. If the answer is no, then move directly to when this current stockout started. Once all the questions from left to right are finished for male condoms, move on to the next method and start the process again]				
2D-13.	Type of Contraceptive Method	Do you Provide this Method to Youth?	Is ___ available Today	Was there a stockout of ____ since December 1st, 2016?	If yes, how many days did the stockout of _____ last?
2D-14.	A. Male Condoms	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	
2D-15.	B. Oral Pills	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	
2D-16.	C. Injectables	((1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	
2D-17.	D. Implants	(1) Yes (2) No (99) DK	(1) Yes (2) No (99)	(1) Yes (2) No (99) DK	

			DK		
2E	**DEMAND GENERATION & BEHAVIOR CHANGE** Now I want to talk to you about any activities you have been involved with that aim to increase the knowledge and change the behavior of people in your community about sexual and reproductive health and contraceptive methods				
2E-01.	In the last 3 months, have you participated in events with youth in your community that aims to increase their knowledge and skills on sexual and reproductive health, HIV prevention, and family planning? These can include youth fairs, social weekends, community dramas, and open days			(1) Yes (2) No (99) DK	
2E-02.	[If yes] how many events did you participate in the last 3 months?			_____ _____	
2E-03.	In the last 3 months, have you participated in any meetings with parents, village chiefs, or religious leaders in your community specifically about increasing knowledge and utilization of contraceptive methods and HIV prevention?			(1) Yes (2) No (99) DK	
2E-04.	[If yes] how many meetings did you participate in the last 3 months?			_____ _____	
2E-05.	In the last 3 months, have you participated in any alternative spaces that aim to provide information and build skills among youth for HIV prevention and family planning? For example, youth clubs, youth centres, non-formal education settings where youth meet			(1) Yes (2) No (99) DK	
2E-06.	[If yes] how many youth spaces did you participate in the last 3 months?			_____ _____	
2E-07.	In the last 3 months, have you participated in any hotlines, internet, radio, or mobile technology programs that are set up for youth to receive information, and answer questions on sexual and reproductive health, HIV prevention, and family planning?			(1) Yes (2) No (99) DK	
2E-08.	In the last 3 months, have you worked with interpersonal agents, reproductive health agents (RHAs), peer educators, or youth CBDAs to provide FP to youth?			(1) Yes (2) No (99) DK	

2E-09.	If yes to above, which type of agent did they work with?		(1) Interpersonal agents, (2) Reproductive health agents (RHAs) (3) Peer educators (4) Youth CBDAs
2E-10.	Do any NGOs or other groups provide you with contraceptive products (like condoms or pills) whose packaging has been designed to target youth? For example, SafePlan injectables, Chisango, CARE, or Protector condoms		(1) Yes (2) No (99) DK
2F	**SUPERVISION** Now I want to ask you some questions about the supervision you have personally received for the family planning services you provide		
1G-06.	Do you receive supervision visits for the family planning services your provide at your facility?		(1) Yes (2) No
1G-07.	[If yes, ask]: when was the most recent time you were supervised for FP?		(7) Yes in the past month (8) Yes in the past 3 months (9) Yes in the past 4-6 months (10) Yes in the past 7-12 months (11) Yes, more than 12 months ago
1G-08.	How many times in the last **<u>6 months</u>** did you receive supervision from an _____ (HSA Supervisor for HSA/CBDA, Supervisor for HFW)?		
1G-09.	How many times in the last **<u>6 months</u>** did you receive supervision from someone outside the health facility, like someone from the district, from the national government, or from a donor?		
1G-10.	The last time you were supervised, did your supervisor review… [then ask A through J]	A. The availability of contraceptive methods	(1) Yes (2) No (99) DK
1G-11.		B. Review your registry	(1) Yes (2) No (99) DK
1G-12.		C. Review trends in your provision	(1) Yes (2) No

			(99) DK
1G-13.		D. Reviews the quality of your service	(1) Yes (2) No (99) DK
1G-14.		E. Instructs on specific FP challenges you may have faced	(1) Yes (2) No (99) DK
1G-15.		F. Reviews clinical case scenarios with you	(1) Yes (2) No (99) DK
1G-16.		G. Observes you providing FP	(1) Yes (2) No (99) DK
1G-17.		H. Demonstrates how to provide FP services	(1) Yes (2) No (99) DK
1G-18.		I. Uses a supervision checklist	(1) Yes (2) No (99) DK
1G-19.	During your last supervision visit, did your supervisor review anything specific to providing family planning services to youth clients?		(1) Yes (2) No (99) DK

Thank the respondent and ask them if they have any last questions.

C3. Health Surveillance Agent and Community-Based Distribution Agent Survey Instrument

Form 3. Mobile Interview of HW Questionnaire		
3A	**ADMINISTRATION**	
2A-24.	Interviewer name	
2A-25.	Date of interview	
2A-26.	District name	Can assign zone during analysis phase
2A-27.	District code	NSO has standard district codes
2A-28.	Name of Health facility	
2A-29.	Affiliation of the facility they are associated with	(1) Government (MOH/LG) (2) CHAM (3) NGO: (specify:)

	(get their materials from):	(8) Other		
2A-30.	Type of facility:	(1) Central Hospital (2) District Hospital (3) Health Centre (4) Health Post (8) other (specify):		
2A-31.	Locality of Community they work out of:	(1) Rural (2) Urban (3) Peri-urban		
2A-32.	Type of Health Worker	(4) Health Facility Worker (5) Health Surveillance Agent (HSA) (6) Community-Based Distribution Agent (CBDA)		
2A-33.	First and Last Name of Health Worker	First Name _____ Last Name _____		
2A-34.	HW Telephone Number			
2A-35.	Call Attempt 1	Call Attempt 2	Call Attempt 3	Call Attempt 4
2A-36.	Date:	Date:	Date:	Date:
2A-37.	Time:	Time:	Time:	Time:
2A-38.	Result code:	Result code:	Result code:	Result code:
2A-39.	Call Attempt 5	Call Attempt 6	Call Attempt 7	Call Attempt 8
2A-40.	Date:	Date:	Date:	Date:
2A-41.	Time: :	Time:	Time:	Time:
2A-42.	Result code:	Result code:	Result code:	Result code:
	Result Codes: 1= Completed, 2= Rescheduled call, 3 = Ring but no answer, 4= "cannot be reached" or out-of-network, 5 = Busy signal or "on other line", 6= "wrong number" or "does not exist"; 7=No mobile phone, 9 = Other			
2A-43.	Special Arrangements/Reschedule Plan:			
2A-44.	Time interview begun	__ __ h __ __ min		
2A-45.	Read brief script about who we are and then ask if they provide FP	(1) Yes (2) No → **END**		
2A-46.	In your current position, do you personally provide any	(1) Yes (2) No → **END**		

	family planning or HIV services?	
2A-47.	If yes, read the informed consent script to the HP. Does the HP give their consent for this interview?	(1) Yes (2) No → **END**
3B	**DEMOGRAPHICS**	
	I would like to ask some questions about your personal, educational, and professional background.	
2B-09.	How old were you at your last birthday? [Record Age in completed years]	__ ___
2B-10.	Are you male or female?	(1) Male (2) Female
2B-11.	What is your religion [specify sect, if needed]	(9) Catholic (10) CCAP (11) Anglican (12) Seventh Day Adventist/Baptist (13) Other Christian (14) Muslim (15) No Religion (16) Other_____
2B-12.	What is your marital status?	(1) Married (traditional, religious, or civil marriage) (2) In a relationship, but not married (3) Separated/divorced (4) Widowed (5) Single (6) Other (specify) _____
2B-13.	What is the highest educational qualification you have achieved?	(7) Primary School Living Certificate (8) Secondary School Junior Certificate (9) Secondary Malawi School Certificate of Education Examination (MSCe) (10) College Certificate (11) College Diploma (12) College Degree
2B-14.	What year did you start working as this occupation?	Year _ _ _ _
2B-15.	What year did you start working in this catchment area?	Year _ _ _ _

3C	PROVIDER TRAINING		
	Now I want to ask you about some general training questions.		
2C-12.	Have you ever been trained to provide family planning services?		(1) Yes (2) No→ **3C-07**
	I now want to ask you about the types of family planning training you have received [Go through each Training type below from left to right. For example, first ask if the training they have received training included FP counseling. If yes, ask if that training occurred in since Jan 2015 (in the last two years). Then ask if they received any refresher trainings since Jan 2015]		
		Did training for _____ include:	Did training for _____ occur since Jan 2015?
2C-13.	General counseling for FP	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-14.	Providing injectables (e.g. Depo Provera)	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-15.	Providing implants (e.g. Jadele)	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-16.	Providing condoms	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-17.	Provide oral contraceptive pills	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK
2C-18.	Have you ever been trained in providing Youth-Friendly Health Services (YFHS)?		(1) Yes (2) No→ **3D-01**
2C-19.	[If yes] Did the YFHS training occur since Jan 2015?		(1) Yes (2) No (99) DK
2C-20.	Have you ever been trained in providing HIV prevention services?		(1) Yes (2) No (99) DK
2C-21.	[If yes] Did this HIV prevention training occur since Jan 2015?		(1) Yes (2) No (99) DK

3D	ACCESSIBILITY OF FP SERVICES TO YOUTH	
	Now I want to ask you about when and how you provide family planning and HIV prevention services	
3D-01.	For most of your work, do you work at a health facility (not health post) or in the community?	(1) Health Facility (2) Community
3D-02.	In the last 3 months, have you participated in any mobile outreach clinics that provide contraceptive methods to hard-to-reach areas in your community?	(1) Yes (2) No (99) DK
3D-03.	[If yes] how many outreach clinics did you participate in the last 3 months?	_____ _____
3D-04.	How many days in a typical week do you provide family planning or HIV prevention services? (If needed, prompt for each day.) [Enter a number between 0 and 7. Enter 0 for less than 1 day per month. Enter -88 for do not know, - 99 for no response]	Number of days: _____
3D-05.	On the days you provide these services, how many hours on average do you provide family planning and HIV prevention services?	Number of hours: _____
3D-06.	On the days you provide family planning and HIV prevention services, what part of the day do you usually provide?	(4) Morning (9-12) (5) Afternoon (12-4) (6) Evening (4-7)
3D-07.	Do you have any special days where you provide family planning and HIV prevention services for youth?	(1) Yes (2) No (99) DK
3D-08.	[If yes] how often do you have these special days for youth family planning and HIV prevention services?	(7) Once a week (8) Once every two weeks (9) Once every month (10) Once every 2 months (11) Once every 6 months (99) DK
3D-09.	Do you have special strategies to target youth for family planning and HIV prevention services, in terms of locations in the community?	(1) Yes (2) No (99) DK
3D-10.	If yes, what kinds of strategies do you have for providing FP to youth, in terms of locations where you provide FP?	(1) Provide FP services near schools and boarding houses (2) Provide commodities near shopping centers (3) Go door-to-door to households with

		youth (4) Other:	
3D-11.	As part of your work, do you personally provide FP or HIV prevention services that are designed to be youth or adolescent friendly? (designed to encourage youth or adolescent utilization?)		(1) Yes (2) No (99) DK
	I want to ask a couple questions about how you refer clients in your community for family planning or HIV prevention services		
3D-12.	In the last 3 months, have you made any referrals to nearby health facilities for family planning and HIV prevention services	(1) Yes (2) No (99) DK	
3D-13.	[If yes] what was the most common reason for referring a client to nearby health facilities?		(1) Didn't have method due to stockout (2) Client wanted a method that you don't normally provide (3) Couldn't provide counseling that client needed (4) Client needed other medical attention outside of just FP (e.g. HIV, MCH) (5) Other: _____
3E	**Availability and Provision of Contraceptive Methods, Supplies, and Equipment**		
	Now I want to ask you about some questions about the contraceptive methods you provide		
2E-11.	Do you have any printed guidelines or protocols for providing contraceptive methods to clients of all ages?		(1) Yes (2) No (99) DK
2E-12.	Do you have any guidelines or protocols for providing contraceptive methods to YOUTH clients specifically?		(1) Yes (2) No (99) DK
2E-13.	When you provide counseling to youth about family planning or HIV prevention, what are the types of issues you usually counsel them about?	J. Information on the range of method options available K. How to use the method L. How to have safe sex M. Potential risks and side effects of each method N. STDs, including HIV O. Reduce stigma around FP P. Where youth can access contraceptives	

	(probe and record all responses)	Q. Promoting abstinence R. Changing contraceptive use behavior S. Advice on when is the best time for youth to have their first baby T. Advice to those with children on when they want to have another baby (&/or whether to wait)
2E-14.	When you provide family planning and HIV prevention counseling or contraceptive methods to youth, how often are you able to find a space where no one can SEE the interaction?	(4) Never (5) Sometimes (6) Always
2E-15.	When you provide family planning and HIV prevention counseling or contraceptive methods to youth, how often are you able to find a space where no one can HEAR the interaction?	(4) Never (5) Sometimes (6) Always
2E-16.	When you provide family planning and HIV prevention counseling or contraceptive methods to youth, how often are you able to tell them that your conversation is confidential?	(5) Never (6) Sometimes (7) Always
2E-17.	When you provide family planning and HIV prevention counseling or contraceptive methods clients, do you have job aids or pamphlets for family planning that can help you counsel?	(1) Yes (2) No (99) DK

I now want to ask you about the types of contraceptive methods to youth you provide and how available they have been for you recently

[Go through each contraceptive method below from left to right. For example, first ask if they provide male condoms. If yes, ask if it is available today. Then ask if they have experienced a stockout for male condoms since January 1st, 2017. If the answer is yes, ask them how many days the stockout lasted for. If the answer is no, then move directly to when this current stockout started. Once all the questions from left to right are finished for male condoms, move on to the next method and start the process again]

	Type of contraceptive Method	Do you Provide this Method to Youth?	Is it available Today	Was there a stockout since Jan 1st, 2017 of X?	If yes, how many days did the latest stockout last?
2E-18.	A. Male Condoms	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	
2E-19.	B. Oral Pills	(1) Yes (2) No	(1) Yes (2) No	(1) Yes (2) No	

		(99) DK	(99) DK	(99) DK	
2E-20.	C. Injectables	((1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	
2E-21.	D. Implants	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	(1) Yes (2) No (99) DK	
	Now I want to ask you some questions about the monthly form that you fill out that tracks how many contraceptive methods you have given to different clients in your community. Can you please bring this register in front of you [Wait until they say they have it]				

2E-22. From your family planning register, please tell me:
(1) The total number of family planning visits (new and continuing) in the **last 7 days [ADD ACTUAL DATE HERE]**, for each method.
(2) The number of new clients who received family planning services in the last 7 days, for each method.
(3) The number of clients who were between the age of 15 to 19 in the last 7 days
(4) The number of clients who were between the age of 20 to 24 in the last 7 days

Enter -88 for do not know, enter -99 for no response.

	# of visits	# new clients	# of women 15-19	# w n 24
Pill (Lo-Femenal)				
Pill (Ovrette)				
Male Condom				
Injectables-Depo				

3F	**DEMAND GENERATION & BEHAVIOR CHANGE** Now I want to talk to you about any activities you have been involved with that aim to increase the knowledge and change the behavior of people in your community about sexual and reproductive health and contraceptive methods	
3F-01.	In the last 3 months, have you participated in any events with youth in your community that aims to increase their knowledge and skills on sexual and reproductive health, HIV prevention, and family planning? These can include youth fairs, social weekends, and community dramas	(1) Yes (2) No (99) DK
3F-02.	[If yes] how many events did you participate in	_____ _____

	the last 3 months?	
3F-03.	In the last 3 months, have you gone door-to-door in your community to deliver health talks on sexual and reproductive health, HIV prevention, and family planning to youth?	(1) Yes (2) No (99) DK
3F-04.	[If yes] how many door-to-door health talks do you think you delivered in the last 3 months?	_____ _____
3F-05.	In the last 3 months, have you participated in any meetings with parents, village chiefs, or religious leaders in your community specifically about youth in their communities getting counseling on sexual and reproductive health, HIV prevention, or using family planning methods?	(1) Yes (2) No (99) DK
3F-06.	[If yes] how many meetings did you participate in the last 3 months?	_____ _____
3F-07.	In the last 3 months, have you participated in any alternative spaces that aim to provide information and build skills among youth for family planning or HIV prevention? For example, youth clubs, youth centres, non-formal education settings where youth meet	(1) Yes (2) No (99) DK
3F-08.	[If yes] how many youth spaces did you participate in the last 3 months?	_____ _____
3F-09.	In the last 3 months, have you participated in any hotlines, internet, radio, or mobile technology programs that are set up for youth to receive information, and answer questions on sexual and reproductive health, HIV prevention, and FP?	(1) Yes (2) No (99) DK
3F-10.	In the last 3 months, have you worked with interpersonal agents, reproductive health agents (RHAs), peer educators, or youth CBDAs to provide family planning or HIV prevention services to youth?	(1) Yes (2) No (99) DK
3F-11.	If yes to above, which type of agent did they work with?	(5) Interpersonal agents, (6) Reproductive health agents (RHAs) (7) Peer educators (8) Youth CBDAs
3F-12.	Do any NGOs or other groups provide you with contraceptive products (like condoms or pills) whose packaging has been designed to target	(1) Yes (2) No (99) DK

	youth? For example, SafePlan injectables, Chisango, CARE, or Protector condoms		
3G	**SUPERVISION** Now I want to ask you some questions about the supervision you have received for the family planning services you provide		
1G-20.	Do you receive supervision visits for the family planning and HIV prevention services you provide in your community?		(1) Yes (2) No (99) DK
1G-21.	[If yes, ask]: when was the most recent time you received a supervised visit for this?		(12) Yes in the past month (13) Yes in the past 3 months (14) Yes in the past 4-6 months (15) Yes in the past 7-12 months (16) Yes, more than 12 months ago (17) No
1G-22.	How many times in the last **3 months** did you receive a supervision visit from an HSA Supervisor?		
1G-23.	How many times in the last **6 months** did you receive supervision from someone outside the health facility, like someone from the district, from the national government, or from a donor?		
1G-24.	The last time you were supervised, did your supervisor… [then ask A through J]	J. Review the availability of contraceptive methods	(1) Yes (2) No (99) DK
1G-25.		K. Review your registry	(1) Yes (2) No (99) DK
1G-26.		L. Review your trends in provision	(1) Yes (2) No (99) DK
1G-27.		M. Review the quality of your service	(1) Yes (2) No (99) DK
1G-28.		N. Instruct on specific FP challenges you faced	(1) Yes (2) No (99) DK
1G-29.		O. Review clinical case scenarios	(1) Yes

		with you	(2) No (99) DK
1G-30.		P. Observe you providing FP	(1) Yes (2) No (99) DK
1G-31.		Q. Demonstrated how to correctly provide FP services	(1) Yes (2) No (99) DK
1G-32.		R. Use a supervision checklist	(1) Yes (2) No (99) DK
1G-33.	During your last supervision visit, did your supervisor review anything specific to providing family planning or HIV prevention services to youth clients?		(1) Yes (2) No (99) DK

Thank the respondent and ask them if they have any last questions.

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Curriculum Vitae for Anooj Pattnaik

July 12, 1984; Manchester, NH

EDUCATION

Doctor of Public Health Graduating in December 2018
Health Systems Program, Department of International Health
Johns Hopkins Bloomberg School of Public Health, Baltimore, MD
Committee: Scott Zeger, Amy Tsui, Melissa Marx, Neff Walker, Kunle Alonge, Scott Radloff

Masters of Public Health Graduated in May 2013
Health Systems and Finance Program
Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

Bachelor of Science in Psychobiology Graduated in April 2007
University of California, Los Angeles

WORK EXPERIENCE

Researcher September 2015 – Current
Institute of International Programs (IIP) Johns Hopkins Bloomberg School of Public Health, Baltimore, MD

- Conducted systematic literature review of ASRH, family planning in LMICs to develop key, measurable indicators
- Designed and led nationwide evaluation of how strongly youth FP programs in Malawi are being implemented via mobile phone interviews with every facility and community health worker in the country
- Led IRB process both at Johns Hopkins and in Malawi
- Developed all data collection instruments, coded in ODK, and uploaded to local tablets
- Trained over 100 data collectors and supervisors on the evaluation and managed the data collection process
- Conducted complex quantitative analysis, including using Bayesian statistics and GIS, to develop indices and to test association between implementation strength and FP outcomes from the DHS; used data visualization skills
- Assisted with qualitative components of FGDs and IDIs with Malawi youth and health workers
- Designed and conducted stakeholder mapping of all FP implementation actors in each district of Malawi
- Used FamPlan tool to model how Malawi MOH FP goals can be met if programs are scaled up
- Ensuing reports from all arms of the project to be published in 2019; will be lead author for at least 3 papers
- Presented findings to local and global stakeholders, including Malawi NSO, MOH, and funder

Short-Term Consultant September 2015 – June 2018
World Bank, Health, Nutrition and Population, Washington, D.C.
Worked on several projects across different regions and practice areas within health during the doctoral program

- Lead author for Malawi case study for the Universal Health Coverage Case Study Series; published in 2018
- Analyzed findings and developed a synthesis report for seven case studies emerging from the Health Systems Strengthening Technical Assistant Facility funded by the World Bank and GAVI
- Conducted literature review and co-authored a report that discussed major findings on the background, impact of, and policy options for addressing dual practice in the health system of Saudi Arabia
- Integral member of the Joint Learning Network for Universal Health Coverage (JLN) team, coordinating with countries to share best practices and develop practical approaches to achieve UHC

Associate Health Specialist **J**une 2013 – August 2015
World Bank, Health, Nutrition and Population, Washington, D.C.
- Managed the Universal Health Coverage Capacity Assessment Tool (UNICAT), which assesses UHC implementation through quantitative analysis and qualitative input from national stakeholders
- Led data analysis to identify key trends and areas of convergence and divergence across countries and the variety of perceptions about how aspects of the health system are functioning
- Led in-country focus group discussions with country staff and stakeholders
- Primary author of the Final UNICAT Report, which reviewed how the tool was developed, the key results, its strengths and limitations, and possible next steps
- Key contributor of synthesis of country case studies on UHC implementation, including data analysis and writing chapters. Published in early 2015
- Conducted systematic literature reviews and data analysis for topics such as NCD issues related to sugar-sweetened beverages and universal health coverage in lower and middle-income countries
- Key member on several operational projects in the Middle East on governance and human resources for health, and chronic disease in the Philippines

Project Coordinator May 2008 – June 2012
National Network of Public Health Institutes, New Orleans, LA
- Coordinated a national program that brought hundreds of state and local health departments together with other system partners to improve the quality of public health services at the city, county, and state levels
- Led the tracking and managing of hundreds of individual QI projects and provided technical assistance
- Worked on a national partnership initiative that developed assessment standards for state and local health systems
- Helped develop a statewide collaborative that promotes the health for those infected with HIV/AIDS through public-private partnering at the community, parish and state levels.
- Successfully wrote and attained grants for essential funding of programs for NNPHI
- Planned, facilitated, and executed dozens of successful national in-person meetings and webinars

- Redesigned several program websites and created numerous online tools, such as the Public Health Improvement Toolkit: an online collection of QI tools shared by public health practitioners
- Consistently represented the organization at national conferences, site visits, and webinars

Clerk July 2006 – Sept. 2006
U.S. Environmental Protection Agency, Office of Research & Development, Office of Science Policy, Washington D.C.
- Supported top officials in developing a risk management strategy for nanotechnology through development of EPA's External Review Draft Nanotechnology White Paper
- Advised on the construction of guidelines for the cleanup of former methamphetamine laboratories

PROFESSIONAL DEVELOPMENT
- Proficient in STATA, R, ArcGIS, ODK, Access, Excel, Powerpoint, Word, Adobe Acrobat, EndNote, Mendeley, LiST & FamPlan, Online Survey Tools, Constant Contact, Dropbox, GoToMeeting, Outlook, GoAnimate
- Fluent: English & Oriya; Basic Proficiency: Bengali, Hindi, Spanish, Telugu

PUBLICATIONS
Pattnaik, A., Mohan, D., Chipokosa, S., Misomali, A., Kachale, F., Ndawala, J., Marx, M. (n.d.). Testing the Validity of Using a Mobile Phone-Based Method to Assess the Strength of Implementation of Family Planning Programs in Malawi. In preparation

Pattnaik, A., Mohan, D., Zeger, S., Marx, M. (n.d.). Comparing quantitative methods that construct multi-level composite implementation strength scores of family planning programs in Malawi. In preparation

Pattnaik, A., Mohan, D., Kachale, F., Ndawala, J., Marx, M. (n.d.). The aggregate effect of implementation strength of family planning programs on modern contraceptive use at the health systems level in Malawi. In preparation

Chipokosa, S., Pattnaik, A., Misomali, A., Mohan, D., Peters, M., Kachale, F., Ndawala, J., Marx, M. (n.d.) How strong are Malawi's family planning programs for adolescent and adult women? Results of a national assessment of Implementation Strength conducted by Malawi's National Evaluation Platform**.** *Journal of Global Health*. In press

Chansa, Collins; Pattnaik, Anooj. Expanding Health Care Provision in a Low-Income Country : The Experience of Malawi. Universal Health Coverage Studies Series;No. 34. World Bank, Washington, DC. World Bank. 2018.

Pattnaik, A., Nair, D., Pascual, B., "Lessons from Health System Strengthening Technical Assistance in 7 Countries." Gavi and World Bank. March 2016

Cotlear, Daniel; Nagpal, Somil; Tandon, Ajay; Smith, Owen; Pattnaik, Anooj. "Going Universal: How 24 Countries are Implementing Universal Health Coverage from the Bottom Up." World Bank Publications. 2015.

Leslie M. Beitsch, MD, JD; Henry Carretta, PhD, MPH; Jennifer McKeever, MPH, MSW; Anooj Pattnaik, BS; Sarah Gillen, MPH. "The Quantitative Story Behind the Quality Improvement Storyboards: A Synthesis of Quality Improvement Projects Conducted by the Multi-State Learning Collaborative." *Journal of Public Health Management and Practice* (2013).

Leslie M. Beitsch, MD, JD, Anooj Pattnaik MPH, Kusuma Madamala, PhD, "The Multi-State Learning Collaborative Storyboards: Quality Improvement Lessons Learned from 162 Projects." *Florida Public Health Review,* (2013)